BOTANICAL EXPLORATION IN THE GREAT NICOBAR ISLAND

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Introduction—The Andamans and Nicobars are a group of islands formed by the summits of a submarine range connected with the Arakan Yoma of Burma. This curved line of submarine hills extends for 700 miles and encloses the Andaman Sea, bounded on the east by the coast of Burma, Malaya and Sumatra (Map I). The Great Nicobar Island (lat. 6° 40′–7° 20′, long. 93° 30′–94° 00′) lies about 300 miles south of Port Blair and about 120 miles north of Sumatra and covers an area of approx. 330 sq. miles. The island has large stretches of flat land and mountain ranges running north-south and east-west. The latter range is comparatively elevated, the highest point being Mt. Thuillier, 2,105 ft. Rainfall is very heavy and is probably about 200 inches. The island abounds in springs, streams and has five rivers, of which Galathea River is fairly big sized.

The country has been quite a *terra incognita* and very little was known about its forest wealth and people. Previous explorers had spent brief periods on the island and none had really penetrated its dark interior, which is inhabited rather sparsely by a wild and primitive people, the "Shompens" a tribe of Malayan origin. Marine surveys around the island were carried out by the Austrian frigate *Novara* during its voyage round the world and also by the Danish corvette *Galathea* during the middle of the 19th century.

At the instance of the Inspector-General of Forests, Shri M. D. Chaturvedi, the Survey of India carried out an aerial photographic survey in 1951. The photographs revealed an exceedingly dense tropical jungle with good sized stands of timber. The present expedition set out in February, 1952 from Port Blair in two motor boats, *M.V. Valdora* (33 tons) and *M.V. Molly*. The party consisted of Shri B. S. Chengappa, Conservator of Forests, Andamans (leader), Dr. P. R. Sondhi (Medical), G. B. Dass (Survey of India), B. Subramanyam (Forests) and the author along with three foresters and several forest labourers.

A successful landing was made on the evening of February 26th. The *Valdora* anchored in a well sheltered bay which was christened Valdora Bay. An expedition camp was put up on the coast. As the party explored they put up several camps around the island and an advance party spent many nights in the interior camping along the rivers and on hills in Shompen type of huts, which expedition members put up themselves. (Camps Map II).

The vegetation is predominantly of the Andamans type with a mixture of Malayan and Sumatran species. However, the two principal Andaman timbers "*Gurjan*" and "*Padauk*" were not seen in the island. Tree ferns which are not known to occur in the Andamans are common in the moist valleys of the Great Nicobar. Several species appear to be endemic but no estimate is yet available about the degree of endemism as some of the species collected, which appear to be endemic, are at present under investigation.

With the exception of some sandstone hills on the northern coast, and the standstone ranges on the eastern side of the Galathea Bay in the south, nothing is reported about the geology of the island. It is regretted that no geologist was made available to accompany the expedition.

The different types of soils of the island are mixed with decayed vegetable matter and are, therefore, very fertile. Humus soil is predominant in areas under dense forest. There is also a light coloured clay following the sandstone formations exposed near streams and rivers.

Types of Forests—The vegetation is differentiated into distinct types of forest growth and these are classified as follows : beach forest, littoral, mangrove, evergreen and deciduous.

Beach forest—Along the beaches there is luxuriant growth of trees, shrubs and climbers. The commonest shrub, *Scævola frutescens* (Mill.) Krause syn. *S. kœnigii* Vahl, with pale-green leaves, grows within reach of the waves and occurs gregariously for miles. Commonly associated with it are *Hibiscus tiliaceus* Linn. and *Clerodendron inerme* (L.) Gaertn., the latter being comparatively scarce. Species of *Pandanus* form impenetrable thickets. *Ipomœa pes-capræ* (Linn.) Roth. syn. *I. biloba* Forsk. grows abundantly along dry sandy beaches and protects the shore ; shrubs of *Atalantia spinosa* Tanaka syn. *A. monophylla* Corr. are common along Valdora Bay. *Tournefortia argentea* Linn.f., a large shrub or small sized tree with silvery pubescent leaves, is common along the beaches of Southern Nicobar. *Cocos nucifera* Linn. occurs abundantly in the Nicobars and in the Great Nicobar, it occurs more profusely on the west coast than on the east coast because of a sparse human population. On the east coast it is freely ravaged by monkeys.

Littoral forest—This zone extends from a few yards to a mile in width, and is composed of trees like *Barringtonia asiatica* (Linn.) Kurz syn. *B. speciosa* Forst., *Erythrina indica* Lam. (scarce), *Guettarda speciosa* Linn., *Thespesia populnea* (Linn.) Sol., *Pithecellobium angulatum* Benth. (scarce), *Pongamia pinnata* (L.) Merr. syn. *P. glabra* Vent., *Heritiera littoralis* Dryand., *Ixora* spp., *Cycas rumphii* Miq., *Cerbera manghas* Linn. syn. *C. odollam* Gaertn. and *Ochrosia borbonica* Gmel. The last two look ornamental. The common littoral timber species are *Calophyllum inophyllum* Linn., *Terminalia catappa* Linn. and *Casuarina equisetifolia* Linn. The last named species is characteristic of dry sandy beaches. Magnificent stands of this timber with good natural regeneration occur along Casuarina Bay.

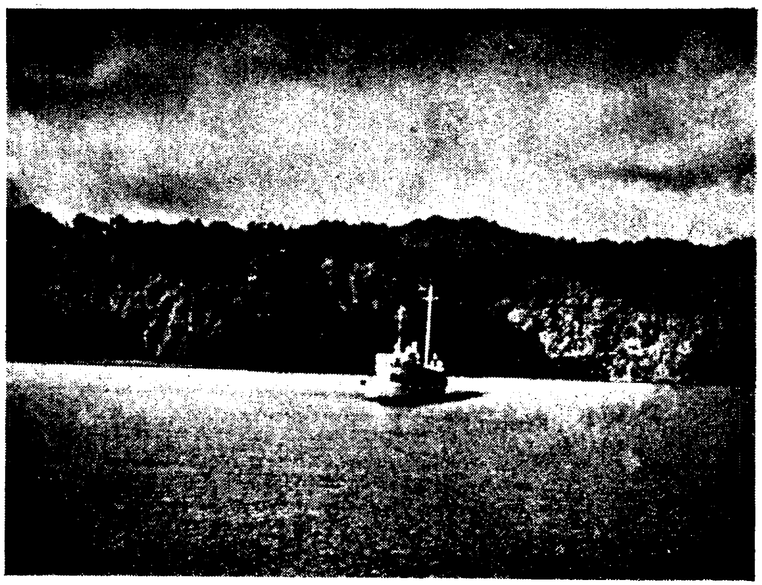
Mangrove forest—Mangrove forests are frequent along the tidal creeks, which unlike those in the Andamans do not penetrate far inland, the only exception being the tidal creek in Ganges Harbour which merges into the Jubilee River. Mangrove swamps are formed of *Bruguiera conjugata* (Linn.) Merr. and *Carallia brachiata* (Lour.) Merr. syn. *C. integerrima* DC. which are valuable and durable timbers and were very much in demand in Australia during the war for telegraph and transmission poles. Fairly large quantities of these can be extracted from the numerous creeks in the island particularly the creeks in the Ganges Harbour and Pulo Babi. The gregarious zone of *Bruguiera* is followed by patches of *Sonneratia acida* Linn.f. and the magnificent *Nipa* palms (*Nipa fruticans* Wurmb.) which occur gregariously along the muddy banks of creeks. This in turn is followed by a belt of *Areca triandra* Roxb., which again is a gregarious littoral species, but in the interior in evergreen forests there are isolated trees here and there. The trees in the littoral areas are densely covered with epiphytic ferns (mostly *Asplenium nidus* Linn.) and orchids (usually *Dendrobium* sp. and *Bulbophyllum* sp.). The change from one type of forest to another is gradual, the exception being the abrupt change over from mangrove vegetation to evergreen which is brought about when fresh water streams merge into salt water creeks.

Evergreen forest—The evergreen forests are the most extensive and clothe the mountain ranges and the flat areas. The species of evergreen zone are *Calophyllum soulattri* Burm.f. syn. *C. spectabile* Willd. which is the most important canoe-wood tree in the Great Nicobar ; *Sideroxylon longipetiolatum* King et Prain, *Endospermum malaccense* Muell. Arg. (scarce), *Garcinia xanthochymus* Hk.f., *Adenanthera pavonina* Linn., *Albizzia lebbeck* (Linn.) Benth., *Pisonia umbellifera* (J.R. et G. Forst.) Seem. syn. *P. excelsa* Blume (Elephant fodder), and *Mangifera sylvatica* Roxb., which is a good plywood timber and usually occurs in flat areas. Under the cover of high trees, there are usually species of *Myristica* and *Polyalthia*. In the moist valleys and along the rivers there are wild plantain, tree ferns up to 30 ft. in height, *Anthocephalus cadamba* Miq., *Pometia pinnata* Forst., *Elæocarpus tuberculatus* Roxb., *Litsea panamonja* Hk.f.,

Beach forest vegetation. *Asplenium nidus* epiphyte in the foreground.

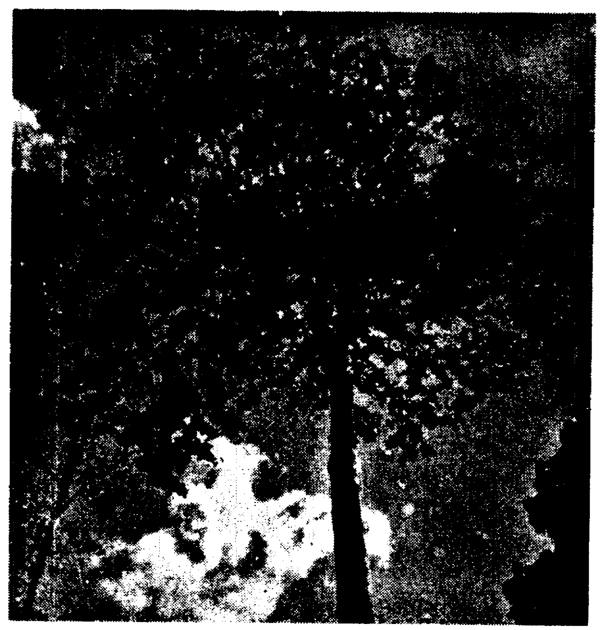
Amoora sp.

Littoral and beach forests in southern Gt. Nicobar. Good sized stands of *Terminalia procera* and *Casuarina equisetifolia*.



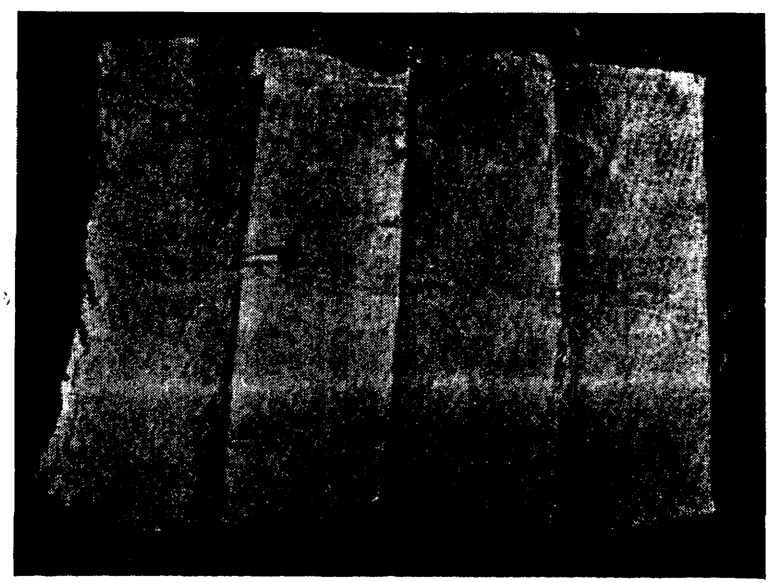
Virgin forest in Gt. Nicobar. *M.V. Valdora* the Expedition launch in the foreground.

Terminalia procera 13 ft. in girth above buttress. Ht. approx. 125 ft. buttress excluded in the photograph to include the crown.



***Terminalia** bialata* one of the largest trees in the island. Ht. 125 ft. and girth 11 ft. above buttress.

Vegetation along Dogmar river. *Gleichenia dichotoma* on the slopes, tree ferns and plantain.



Inner bark of *Ficus* sp. – clothing material of the Shompens.

Terminalia procera Roxb., *Mitrephora* sp. *Ficus* sp. and *Macaranga* sp. In the interior along the banks of the rivers *Phragmites karka* (Retz.) Trin. and *Arundo* sp. are common. In open country along the rivers the slopes are usually covered with bracken and *Gleichenia dichotoma* Hk. Clumps of bamboo and the climbing bamboo *Dinochloa andamanica* Kurz are common along rivers the latter climbing over tall trees. This type of vegetation is characteristic of Dagmar, Alexandra and Galathea Rivers.

Deciduous forests—These occupy only small strips along the coast. They consist mostly of trees which shed their leaves during the hot season. The common forest species are *Terminalia procera* Roxb., characterized by an umbrella shaped crown, *Terminalia bialata* Steud., characterized by winged fruits and a trunk with well developed buttresses. They are large sized straight trees and are useful plywood and matchwood timbers. There are also species of *Albizzia* and *Sterculia*. Species of *Sterculia* occur in fairly large numbers in open country along the rivers. *Pterocymbium tinctorium* (Blanco) Merr. syn. *Sterculia campanulata* Wall. which is a good matchwood timber is the commonest (1). Recent experiments at Dehra Dun indicate that it is a promising raw material for the production of newsprint. The colour of the pulp is also suitable for the purpose. Climbers flourish mostly in the evergreen forest where there is more shade but are scarce in deciduous forest owing to the little shade they get during the hot season. There is no well defind deciduous zone because the deciduous and the evergreens are very much mixed. *Artocarpus chaplasha* Roxb., which is leafless during the hot season, invariably occurs in the evergreen zone. Buttresses seem to be characteristic of several deciduous trees like *Terminalia bialata* Steud., *Artocarpus chaplasha* Roxb., etc. They are less pronounced in *Terminalia procera* Roxb.

The vegetation of the other islands visited in the Nicobars, viz., Car Nicobar, Nancowry, Katchall, Kamorta, Little Nicobar and Kondul is fairly similar to that of Great Nicobar. Timber species are comparatively poor in Car Nicobar, Nancowry, Katchall and Kamorta which are of recent coral origin.

Extent of various types of forests—An estimate of the extent of the various types of forests was carried out by the enumeration party and will be found in Mr. B. S. Chengappa's report to the Government of India. Evergreen forests are the most extensive followed by littoral, beach, deciduous and mangrove forests which are the least extensive. In the Andamans the mangroves cover 1/8th to 1/10th the area. In the Great Nicobar the proportion is probably about the same. It is estimated that on a sustained yield, based on a rotation of 100 years, 30,000 tons of valuable matchwood and plywood timber can be extracted annually from this island. It is about 1/4th the yield of North and South Andamans. The Government may thus expect a royalty of about Rs. 10,00,000 a year.

The mean height of *Terminalia procera* Roxb. and *T. bialata* Steud. growing close to the seashore is approximately 100 ft. The Casuarinas are about the same height and some of the mangroves are 50–60 ft. One *Terminalia procera* Roxb. was 13 ft., in girth above buttress and 125 ft. in height. A *Terminalia bialata* Steud. measured 125 ft. in height and 11 ft. in girth above buttress ; *Terminalia catappa* Linn. – length of bole 76 ft., girth above buttress 4 ft. 9 in., mid-girth 4 ft. 4 in. ; *Sterculia* sp. : clean bole 85 ft., girth at breast height 6 ft. 6 in. mid-girth 6 ft., *Stephegyne* sp. : girth at breast height 5 ft. 6 in., mid-girth 5 ft., clean bole 35 ft. ; *Litsea* sp. : girth at breast height 4 ft. 6 in., mid-girth 4 ft., clean bole 58 ft. (*vide* Appendix for measurement of trees marked*).

Jungle foods of the island—In the Nicobars there are a number of plants with parts that may safely be eaten provided one knows what to select and how to prepare them. The expedition party sought valuable information from the friendly coastal Nicobarese and the primitive Shompens. The latter are a tribe of Malayan origin that is in a most primitive

state of existence, comparable to the stone age and it is difficult to imagine that the absence of an indigenous cereal is not a reflection of its low level of culture. Incidentally their clothing material is provided by the inner bark of a species of *Ficus*. (Pl. 8).

Pandanus is the staple food in the island. The orange-red pulp surrounding the individual fruits is well flavoured and is safe to eat. Its terminal buds are reported to be eaten in islands of the Pacific. The Nicobar coconut palm *Cocos nucifera* Linn. is reputed to be superior to the coconuts in Ceylon, Malaya or on the Indian mainland. The terminal buds of most species of palms are good food, eaten either raw or cooked. In fact the terminal buds of the coconut palm are so good that they are spoken of as "millionaire's Salad" for to secure them one has to destroy the palm. Our Shompen guide plucked for us terminal buds of *Areca triandra* Roxb. which tasted quite nice when raw. This species also occurs in Sumatra and the Andamans and appears to be as good as the areca nut and is freely used by the coastal Nicobarese.

The climbing palm *Calamus andamanicus* Kurz attains a great length climbing over tall trees. It is a source of safe drinking water. Sections 10 ft. long are cut and when held in a vertical position the sap trickles for a time and then ceases. When the flow stops the lower foot or so is cut and the trickle will commence again. Another source in an emergency are the prop roots of *Pandanus* which hold small quantities of moisture.

Colocasias which have large underground corms rich in starch were seen in Shompen gardens in the Great Nicobar and in Car Nicobar. Before eating they should be thoroughly washed and cooked to remove astringency. Most of the tubers of wild Yams (*Dioscorea* spp.) are edible after proper cooking. Roots of some species of *Selaginella* shown to us by Shompens were found to have a pleasant taste.

There are a number of trees that produce edible fruits and seeds, e.g., *Terminalia catappa* Linn., fruits of the genus *Syzygium* (Eugenia) none of which are poisonous, and several of them have a pleasant flavour. The large immature seeds of *Nipa fruticans* Wurmb., which grows in abundance along tidal streams, may be eaten. The large seeds of all species of *Artocarpus* may be freely eaten, either boiled or cooked.

Certain varieties of red bananas raised by Shompens were found to be delicious with a pleasant flavour. They are as good as the red bananas that are seen in the Indian markets. Throughout Malaysia and India the terminal hanging cone-shaped inflorescences of certain varieties of bananas are widely used as a cooked vegetable. Tender growing tips of *Pisonia umbellifera* (J.R. et G. Forst.) Seem. and leaves of *Morinda citrifolia* Linn. and *Thespesia populnea* (Linn.) Sol. may be eaten. It is admitted that the nourishment derived from such plants is not great, yet the greens serve their purpose, and among other things provide certain essential vitamins (·6). It is on record that an expedition in New Guinea in 1920 subsisted for 70 days on such food as they could secure in the forest.

Conclusion—The botanical collections made from the Great Nicobar afford foundation material for a flora of the Nicobars. The botanical survey of the island which lasted about 7 weeks yielded about 180 species (Appendix) and another 50–70 were observed but it was not possible to collect them. It is estimated that the island has about 400 plant species, several of which are useful timbers and a few are either edible or medicinal. It is one of the few islands in Asia that had not been botanically explored, although areas not far from it, viz., Sumatra, Java, Borneo, etc., have been explored by several Dutch and American botanists notably by Dr. E. D. Merrill. M. C. Bonnington in 1914, however, made a collection from Great Nicobar which consists mostly of littoral species. Due to a high degree of endemism in insular areas several of the species in the present collection are likely to be new and there is every reason to believe that future collectors will be amply rewarded by new and interesting

types that might be of economic importance. The flora of the Great Nicobar is in its original form, unmixed or untouched by man owing to its isolated position. Hence the importance of a further botanical exploration of the island cannot be minimized. Willis estimates 800 endemics in the flora of Ceylon, Borneo has 50% and New Guinea has 85% of its species as endemic. It is, therefore, safe to assume that the island of the Malaya Peninsula and the Great Nicobar contain many endemics.

Great Nicobar and Little Nicobar most probably have geological formations similar to those of Sumatra and Malaya and, therefore, are very likely outliers of the Malayan Peninsula. The presence of fresh water crocodiles in some of its rivers, e.g., Galathea River, is evidence of a former land connection, so is the presence of frogs, snakes, lizards, etc.

About 55 timber specimens were collected, they are now under investigation in the Forest Research Institute. The results of the investigation will shortly appear in a future issue of this Journal. Acknowledgement is made to Messrs. Chowdhury and Ghosh for help received in identification in cases where floral material was inadequate. My grateful thanks are due to Shri B. S. Chengappa whose knowledge of the Andamans flora was of great help in the identification of the specimens in the field and to Shri M. B. Raizada, Officer-in-Charge, Botany Branch, whose experience of floras of Bengal, Assam and Burma was of immense help during the identification of the collection. My thanks are also due to Shri R. N. Chatterjee for help received during identification.

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APPENDIX

List of plants collected

ANNONACEÆ

Artabotrys sp. A large climber with yellowish fruits. Loc. Trinkat Champlong Bay Gt. N. 23168.

Polyalthia sp. A medium sized tree with prominent scarlet fruits borne in clusters. Interior of Pulo Kunyi, Gt. N. 22963.

**Polyalthia* sp. A fairly large tree in evergreen forests. Fruits reddish. Timber collected. 23047. Gt. N.

Polyalthia sp.† ? A large shrub to a small tree growing near the coast. Gt. N. 22953.

GUTTIFERÆ

Calophyllum soulattri Burm.f. syn. *C. spectabile* Willd. A medium sized tree in evergreen forests. Used in canœ building. Collected from Mt. Thuillier (22911) and Ganges Harbour. 22939. Gt. N.

Calophyllum inophyllum Linn. A medium sized tree growing in the littoral zone. Flowers white. 22927 and 23035. Gt. N.

Garcinia xanthochymus Hk.f. A small tree occurring gregariously in evergreen forests not far from the coast. Flowers white. Yellowish latex oozes out from the trunk when blazed. Characteristic of the family. Collected from Ganges Harbour (22917) and Pulo Kunyi. 22964. Gt. N.

MALVACEÆ

Hibiscus tiliaceus L. A large shrub to a small sized littoral tree. Valdora Bay. 22924. Gt. N.

Urena sinuata L. A small shrub with pinkish flowers. 23005. Gt. N.

Sida acuta Burm.f. syn. *S. carpinifolia* Linn.f. A herb with yellowish flowers. 23006. Gt. N.

Thespesia populnea (Linn.) Sol. A small littoral tree. 23183. Gt. N.

STERCULIACEÆ

**Pterocymbium tinctorium* (Blanco) Merr. syn. *Sterculia campanulata* Wall. A medium sized tree with greyish bark usually growing in the interior of the island in open areas along river banks. 23040. Gt. N. Timber specimen collected.

**Heritiera littoralis* Dryand. A medium sized littoral tree, leaves with shining white under-surface and keeled fruits of the size of a walnut. 22923. Gt. N. Timber specimen collected (23036).

Sterculia sp. A large tree in evergreen forest. 22924. Gt. N.

**Sterculia* sp. A large tree in evergreen forest with a clear bole of 85 ft., girth at breast height of 6·6 ft., and a mid-girth of 6 ft. 22952. Gt. N. Timber specimen collected. One of the lightest timbers in the collection.

A few plants in this list have been collected from other islands in the Nicobar group. Gt. N. = Great Nicobar.

* Timber specimen collected for Wood Technologist.

† Species marked with a dagger are under investigation. Likely to be new and endemic.

Sterculia villosa Roxb. A tree with large leaves. 22969. Gt. N.

**Sterculia* sp. A medium sized tree in low level semi-deciduous forest with almond shaped fruits. 23043. Gt. N. Timber specimen collected.

TILIACEÆ

**Elæocarpus* near *E. tuberculatus* Roxb. A large tree in evergreen forest. 22943. Gt. N. Timber specimen collected.

Elæocarpus tuberculatus Roxb. A medium sized tree with white flowers (23170) Gt. N.

**Elæocarpus* sp. A medium sized tree in evergreen forest (23044). Gt. N. Timber specimen collected.

RUTACEÆ

Atalantia spinosa Tanaka syn. *A. monophylla* Corr. A small littoral tree, rather scarce in the island. 22932. Gt. N.

Evodia sp. A tree with 3 foliate leaves – collected from Kutchall and Nancowry. 23190.

BURSERACEÆ

Canarium euphyllum Kurz. A medium sized tree in low level semi-deciduous forest. Loc. Koe, Gt. Nicobar. 23034.

MELIACEÆ

Amoora sp. A small sized tree with reddish fruits growing amongst rocks close to sea-shore in a sheltered bay. Ganges Harbour, Gt. Nicobar. 22901.

**Amoora* sp. A large tree in evergreen forest, girth at breast height 7½ ft. Gt. N. Timber specimen collected. 22949.

Aglaia sp. A tree with yellowish ovoid fruit like a Loquat. Loc. Pulo Kunyi, Gt. Nicobar. 22979.

Xylocarpus moluccensis Roem. syn. *Carapa moluccensis* Lamk. A medium sized littoral tree with creamish flowers. 23016. Gt. N.

**Sandoricum* sp. Tree. 22960. Gt. N. Timber collected.

OLACACEÆ

**Gomphandra andamanica* King. A medium sized tree with whitish fruits. Girth at breast height 4 ft. 5 in., mid-girth 3 ft. 9 in. Length of bole 38 ft. 10 in. 22998. Timber collected. Gt. N.

CELASTRACEÆ

Salacia latifolia Wall. A shrub growing in the littoral zone in Gt. N. and Little Nicobar. 23179 and 23185. Little Nicobar.

A few plants in this list have been collected from other islands in the Nicobar group. Gt. N. = Great Nicobar.

* Timber specimen collected for Wood Technologist.

RHAMNACEÆ

Colubrina asiatica (L.) Brongn. A small littoral shrub with greenish flowers. 23164. Gt. N.

VITACEÆ

Leea sp. A small littoral tree. 22933. Gt. N.

Leea sp.† A large littoral herb with greenish flowers. 23152. Gt. N.

Vitis sp. A large herb in littoral forest. Gt. N.

SAPINDACEÆ

Pometia pinnata Forst. A medium sized tree common along rivers in the island. Loc. Alexandra River. 22993. Gt. N.

Allophylus sp. Possibly *A. dimorphus* Radlk. syn. *A. cobbe* Blume. A small shrub with whitish flowers. 23009.

ANACARDIACEÆ

**Spondias* sp.† A big sized tree in evergreen forest. 23037. Gt. N. Timber specimen collected.

Semecarpus kurzii Engler. A medium sized tree common in Car Nicobar, in littoral forests. 23197.

LEGUMINOSÆ

Pongamia pinnata (L.) Merr. syn. *P. glabra* Vent. A small littoral tree growing in a well sheltered bay. Loc. Valdora Bay. 22926 and 22935. Gt. N.

Adenanthera pavonina Linn. A large tree in evergreen forests. Scarce. Interior of Valdora Bay. 22937. Gt. N.

Pithecellobium angulatum Benth. Along Alexandra River. A small tree with whitish flowers. 22991. Gt. N.

Cassia near *C. occidentalis* Linn. A small shrub with yellowish flowers growing in Pulo Babi. 23004. Gt. N.

Mucuna prurita Hk. syn. *Mucuna pruriens* DC. A common leguminous climber growing on shrubs near the coast. Pulo Babi. 23027. Gt. N.

Derris trifoliata Lour. syn. *D. uliginosa* Benth. A climber growing in a mangrove swamp, with pretty pinkish flowers. Lower parts of the plant submerged in water. 23031. Gt. N.

Erythrina indica Lam. A medium sized littoral tree with scarlet flowers. Loc. Campbell Bay. Gt. N. 23155.

Albizzia sp.† Near *A. odoratissima* Benth. A small littoral tree with conspicuous deep violet stamens. Bark whitish. Loc. Trinkut Champlong Bay. 23163. Gt. N.

Desmodium umbellatum (Linn.) DC. A small leguminous tree with whitish flowers common along the coast. 23165. Gt. N.

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* Timber specimen collected for Wood Technologist.

† Species marked with a dagger are under investigation. Likely to be new and endemic.

Moghania strobilifera (Linn.) St. Hill. ex. Jack. Syn. *Flemingia strobilifera* R. Br. A small shrub. 23194. Loc. Kamorta.

Vigna marina (Burm.) Merr. syn. *Vigna lutea* A. Gray. A twiner with yellow flowers common on the beach throughout the island. Casuarina Bay. 22905 and 22973. Gt. N.

ROSACEÆ

**Parastemon* sp. Possibly *P. europhyllum* A. DC. Medium sized tree 60 ft. Frs. pinkish creamish. Pulo Kunyi. 22962. Gt. N. Timber collected.

COMBRETACEÆ

Combretum chinense Roxb. A climber with creamish flowers, climbing on shrubs and trees along the coast. Loc. Trinkat Champlong Bay, Gt. N. 23166.

Terminalia procera Roxb. A large tree with a straight bole common in the littoral zone. 22976. Gt. N.

**Terminalia* sp. Near *T. catappa* Linn. A large sized buttressed littoral tree. Girth above buttress 4 ft. 9 in., mid-girth 4 ft. 4 in. Length of bole 76 ft. 22996. Gt. N. Timber collected.

Terminalia catappa Linn. A medium sized littoral tree. The tree looks magnificent just before leaf-fall when the leaves turn reddish. Loc. Trinkat Champlong Bay. 23161. Gt. N.

MELASTOMACEÆ

Memecylon ovatum Sm. syn. *M. edule* Roxb. *var. ovatum* C. B. Clarke. A small tree. 23196. Kamorta.

Melastoma malabathricum L. A large shrub with pinkish flowers, growing along a tidal creek fairly inland. 22954. Gt. N.

MYRTACEÆ

Eugenia sp. Near *E. pseudoformosa* King. A small tree in evergreen forests collected at 1,000 ft. 22908. Gt. N.

**Eugenia* sp. possibly *E. manii* King. A large sized littoral tree. Girth at breast height 4·7 ft., mid-girth 4 ft., length of bole, 60 ft. 10 in. 22997. Gt. N. Timber collected.

Eugenia sp.† Near *E. formosa* King. A medium sized tree growing along streams with large, scented creamish flowers. 23029. Gt. N.

Eugenia sp. A small tree. Little Nicobar. 23186.

Syzygium pycnanthum Merrill et. Perry syn. *Eugenia densiflora* DC. A small tree. Gt. N.

BARRINGTONIACEÆ

Barringtonia asiatica (Linn.) Kurz syn. *B. speciosa* Forst. A medium sized littoral tree with conspicuous flowers and large fruits. Common throughout the Nicobars. Loc. Valdora Bay. Gt. N. 22921.

Barringtonia racemosa (Linn.) Blume. A small tree along sweet water swamps with pretty pinkish flowers. Jubilee River. 22956. Gt. N.

A few plants in this list have been collected from other islands in the Nicobar group. Gt. N. = Great Nicobar.

* Timber specimen collected for Wood Technologist.

† Species marked with a dagger are under investigation. Likely to be new and endemic.

Barringtonia sp.† A small tree about 40 ft. in height with a greyish bark growing in areas where the canopy is open, usually along the rivers in the interior. Flowers, white, fragrant, the entire tree covered with blossoms in March–April. Not common. 22990. Gt. N.

SAMYDACEÆ

Casearia sp.† A medium sized tree. Car Nicobar. 23198.

RHIZOPHORACEÆ

Bruguiera conjugata (Linn.) Merrill syn. *B. gymnorhiza* Lam. A small littoral tree with scarlet calyx and small orange coloured corolla. 22902. Gt. N.

**Carallia brachiata* (Lour.) Merrill syn. *C. integerrima* DC. A medium sized tree in evergreen forests. 23046. Timber collected. Gt. N.

LYTHRACEÆ

Sonneratia acida Linn.f. A large littoral tree up to 100 ft., also occurring along tidal creeks. 22919. Gt. N.

ARALIACEÆ

Arthrophyllum sp. A medium sized tree found in the high level and low level evergreen forests. 23173. Gt. N.

RUBIACEÆ

Guettarda speciosa Linn. A small littoral tree. 22925.

**Mitragyna* sp. near *M. diversifolia* Hk.f. A moderate sized tree in evergreen forests, girth at breast height 8 ft. 6 in., mid-girth 5 ft. Clear bole 35 ft. Timber collected (22951). 23042. Gt. N.

Morinda citrifolia Linn. A small tree. 22975. Gt. N.

Ophiorrhiza sp. A herb with whitish flowers growing near coastal habitations. Loc. Pulo Babi, Gt. N.

Ixora brunnescens Kurz. A small tree with greenish fruits. 23010. Gt. N.

**Canthium* sp. A medium sized evergreen tree. 23041. Gt. N. Timber collected.

Ixora sp.† Near *I. acuminata* Roxb. A small tree. 23049. Gt. N.

Ixora sp.† A small tree with white flowers. 23050. Gt. N.

Mussœnda macrophylla Wall. A small tree. 23153. Gt. N.

Oldenlandia biflora L. A small herb with white flowers common near coastal habitations. A weed. Pulo Babi. 23022. Gt. N.

COMPOSITEÆ

Wedelia urticæfolia DC. A weed with yellow flowers growing near coastal habitations. Large herb. 22988. Gt. N.

Vernonia sp. A shrub. 23188. Little Nicobar.

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† Species marked with a dagger are under investigation. Likely to be new and endemic.

GOODENIACEÆ

Scævola frutescens (Mill.) Krause syn. *S. kœnigii* Vahl. A large shrub common on the beach throughout the island. Valdora Bay. 22929. Gt. N.

MYRSINACEÆ

Ardisia humilis Vahl. A small littoral tree. Valdora Bay. 22920. Gt. N.

SAPOTACEÆ

Sideroxylon sp. possibly *S. longipetiolatum* King et Prain. A tree in evergreen forest. 22913. Gt. N.

**Palaquium* sp. A medium sized tree up to 60 ft. high in evergreen forest. 22958, (Timber collected). 22980 (Pulo Kunyi). Gt. N.

**Payena* sp.† A tree with creamish flowers and medium in height. 23032. Gt. N. Timber collected.

Sideroxylon ferrugineum Hook. and Arn. A medium sized tree. 23199. Car Nicobar.

APOCYNACEÆ

Cerbera manghas Linn. syn. *C. odollam* Gaertn. A medium sized littoral tree. Valdora Bay. 22928. Gt. N.

**Alstonia kurzii* Hook.f. A moderate sized littoral tree. Valdora Bay. 22941. Gt. N. Timber collected.

**Alstonia macrophylla* Wall. A medium sized tree in semi-deciduous forests. 22983. Gt. N. Timber collected.

Tabernæmontana crispa Roxb. A small shrub with whitish flowers. 22994. Campbell Bay. Gt. N.

ASCLEPIADACEÆ

Hoya sp.† An epiphyte with whitish flowers. Common. Gt. N.

LOGANIACEÆ

Fagræa racemosa Jack. syn. *Fagræa morindifolia* Bl. A small tree with white flowers. 22989, 22938. Gt. N.

CONVOLVULACEÆ

Ipomœa pes-capræ (Linn.) Roth syn. *I* : *biloba* Forsk. A creeper with violet flowers growing on dry sandy beaches. Loc. Casuarina Bay. 22967. Gt. N.

Ipomœa gracilis R. Br. syn. *I. denticulata* Choisy. A creeper with violet flowers growing on sandy beaches. 22968. Gt. N.

BORAGINACEÆ

Cordia subcordata Lam. A small littoral tree with scarlet flowers. 23171. Kondul Island near. Gt. N.

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Tournefortia argentea Linn.f. A small tree with whitish pubescent foliage common on the beach in south of the island. 22986. Gt. N.

ACANTHACEÆ

Acanthus ilicifolius Linn. A small littoral shrub. 23182. Little Nicobar.

BIGNONIACEÆ

Dolichandrone spathacea K. Schum. syn. *D. rheedii* Seem. A small littoral tree with white trumpet-shaped flowers. 23160. Gt. N.

VERBENACEÆ

†*Vitex* sp. Linn. A coastal shrub. Loc. Henhoa. 22985. Gt. N.

Clerodendron paniculatum Linn. A shrub with scarlet flowers. 22987. Gt. N.

Clerodendron inerme (Linn.) Gaertn. A coastal shrub. 23181. Little Nicobar. 23192. Nan Cowry.

LABIATEÆ

Colebrookia oppositifolia Sm. A shrubby herb rare in the island near the coast. Gt. N.

AMARANTHACEÆ

Aerua lanata (Linn.) Juss. A large pubescent herb. 23007. Gt. N.

LAURACEÆ

**Litsea* sp. A large tree in evergreen forest. G.B.H. 4 feet 6 inches; mid girth 4 feet; clear bole 50 feet. 22948. Gt. N. Timber collected.

Litsea ? A small tree. 22918. Gt. N.

Litsea sp.† A medium sized tree with yellowish flowers. Campbell Bay, Gt. N. 23154.

MYRISTICACEÆ

Myristica sp. A small tree with yellow, egg shaped fruits, growing along-side a fresh-water stream. 22903. Gt. N.

Myristica sp. A small tree growing near the sea coast. Valdora Bay. 22930. Gt. N.

**Myristica irya* Gaertn. A large tree in evergreen forest. Loc. Henhoa. 23038. Gt. N. Timber collected.

Myristica sp. A tree in evergreen forest growing at 1,500 feet, near Mt. Thullier 22909. Gt. N.

EUPHORBIACEÆ

Glochidion sp. A large shrub. Gt. N.

Macaranga sp. near *M. indica* Wight. A small littoral tree with whitish flowers. 23162. Gt. N.

Macaranga sp. A small tree. 23175. Gt. N.

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Macaranga tanarius (Linn.) Muell. Arg. A tree with extra-ordinary large leaves. 22972. Gt. N.

Mallotus sp. A tree in evergreen forests. 22912. Gt. N.

Mallotus acuminatus Muell. Arg. A large shrub. Gt. N.

Antidesma sp.† A small shrub growing along a stream. 23030. Gt. N.

Antidesma sp. A small tree. 23195. Gt. N.

**Cleidion* sp. ? A medium sized tree, length of bole 65 ft., girth at breast height 3 ft. 9 in., mid-girth 3 ft. 2 in. 23001. Gt. N. Timber collected.

MORACEÆ

Artocarpus chaplasha Roxb. A large sized tree with a buttress. Valdora Bay. 22936. Gt. N.

**Ficus* sp. A large tree in evergreen forests. 22946. Gt. N. Timber collected.

**Ficus* sp. A large littoral tree with milky latex when cut, girth at breast height 2 ft. 10 in., mid-girth 2 ft. 6 in., length of bole 38 ft. 9 in. 22995. Gt. N. Timber collected.

Ficus sp. A large sized tree. 23002. Gt. N.

Ficus sp. A small tree, latex white. 23028. Gt. N.

Ficus sp. near *F. variegata* Blume. A moderate sized tree. Inner bark used as a clothing material by the "Shompen" tribe. Loc. Galathea River. 23048. Gt. N.

Ficus sp. A medium sized tree in evergreen forests. 23041. Gt. N.

Ficus retusa Linn. A medium sized tree. 23176. Gt. N.

Ficus sp. A medium sized tree. 23046. Gt. N.

Conocephalus suaveolens Bl. A creeper on trees with pinkish flowers. Gt. N. 23023.

PIPERACEÆ

Piper sp. near *P. betle* Linn. A creeper on trees. "Pan" of the Nicobarese. 23024. Gt. N.

CASUARINACEÆ

Casuarina equisetifolia Linn. Large tree forming shelter belts along the sea-shore. Ht. 120 ft. Casuarina Bay. 22971. Gt. N.

PODOCARPACEÆ

Podocarpus wallichianus Presl syn. *Podocarpus latifolia* Wall. A small tree found in the interior of Gt. Nicobar on hill-side above Alexandra River near "Shompen" habitation. 22992. Gt. N.

FLAGELLARIACEÆ

Flagellaria indica Linn. A climber climbing by cirrhose leaf-tips. 23187. Little Nicobar. Also occurs in Gt. N.

CYCADACEÆ

Cycas rumphii Miq. A cycas with dark-green glossy leaves common throughout the island near the sea-shore. 23020. Gt. N.

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PALMÆ

Korthalsia sp. A palm with thorns common in the interior and in jungle close to the coast. 22910. Gt. N.

Korthalsia echinometra Becc. A palm with sharp bristles common in the island. 23012. Gt. N.

Korthalsia sp. A climbing palm with bristles on the stem. 23013. Gt. N.

Areca triandra Roxb. A small palm with edible fruits growing gregariously in the littoral zone. 23011. Gt. N.

PANDANACEÆ

Pandanus tectorius Sol. A small tree with big orangish fruits, – a staple food in the island. 22974. Gt. N.

CYPERACEÆ

Kyllinga monocephala Rottb. A common sedge near habitations on the island. 23025. Gt. N.

GRAMINEÆ

Rottbœllia sp.† A grass growing on sandy beaches. Casuarina Bay. 22977. Gt. N.

Phragmites karka (Retz.) Trin. Common near the coast and along the rivers in the island. 23026. Gt. N.

Dinochloa andamanica Kurz. A climbing bamboo growing on trees – about 100 ft. in length. 23167. Gt. N.

ORCHIDACEÆ

Bulbophyllum sp. An orchid with pinkish-white flowers, epiphytic on littoral *Barringtonia asiatica*. 23017. Gt. N.

Bulbophyllum sp. An orchid with creamish flowers epiphytic on littoral *Barringtonia asiatica*. 23018. Gt. N.

Appendicula sp. ? An orchid with creamish flowers epiphytic on *Barringtonia asiatica*. 23019. Gt. N.

Aerides sp.† An epiphytic orchid. 23178. Little Nicobar.

Saccolabium sp. ? Epiphytic orchid. 23177. Little Nicobar.

LILIACEÆ

Dracœna brachyphylla Kurz. A large shrub to a small sized tree. 22978. Gt. N.

LYCOPODIACEÆ

Lycopodium phlegmaria Linn. A *lycopodium* growing epiphytically on trees on the beach. 22922. Gt. N.

FILICALES

Asplenium nidus Linn. A fern growing epiphytically on trees, common in the island. 23014. Gt. N.

Alsophila sp. A tree fern common in the island, occurring in moist valleys. 23003. Gt. N.

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Pathological Note No. 5

A NEW AND NOTEWORTHY DISEASE OF *GAMHAR* (*GMELINA ARBOREA* LINN.) DUE TO *PORIA RHIZOMORPHA* SP. NOV.

BY K. BAGCHEE, *Mycologist*
Forest Research Institute, Dehra Dun

SUMMARY

The life-history of a stem and root disease fungus attacking *gamhar* (*Gmelina arborea* Linn.) in natural regeneration and plantations in shady, unfavourable and water-logged localities and in the clayey soil in the eastern states of India and Pakistan has been described. The important feature in the life-history of this plant is a cable-like rhizomorph which initially emerges from the tissues of the context as peg-like growth composed of thick-walled, long, septate hyphæ. The rhizomorph is the principal organ of propagation. It perennates in the forests on the substratum of humus, debris, slash and soil and disseminates the disease when moisture is available.

The fungus is a poroid Basidiomycetes and the name *Poria rhizomorpha* sp. nov. has been given to it. The Technical Description and Diagnosis of plant have also been given.

In 1939, Mr. T. Dent, I.F.S., Divisional Forest Officer, Hill Tracts Division, Chittagong Bengal, India, drew my attention to an interesting fungus which "practically strangled" and killed a large number of *gamhar* (*Gmelina arborea* Linn.) trees in Maskumb Plantations, 1923, in Ringkong range. In his letter forwarding the material, which included some mycelia and a portion of *rhizomorph* attached to the decayed timber containing bark and sapwood, Mr. Dent kindly supplied the following information about the fungus and the host.

" The *gamhar* trees in this plantation are of excellent growth and quite free from Loranthus attack, which is prevalent in other ranges of the Division. The average height of the trees affected is 70 to 80 feet and the girth is up to 3 feet 6 inches. The soil is sandy-loam, well-drained and sloping. There is a dense undergrowth of *mooli* bamboos (*Melocanna bambusoides* (Trin.) about 35 feet high.

The attack has just been noticed, and it has spread over an area of 5 to 6 acres. The *gamhar* plants are widely spaced, 30 to 40 feet apart. Some 80 to 100 trees show signs of advanced disease, of which 25% are already dead, and the balance is expected to die very soon.

The bark of the attacked trees is infested with white fungus mycelium from the ground to a distance of 3 to 5 feet up the stem. The whole of the lower stem appears white. The sapwood is weak and brittle and breaks away in blocks when pulled by the fingers. The white fungus appears to be saprophytic, though I think that it is probably the primary parasite also.

The *gamhar* (*Gmelina arborea* Linn.) trees may die singly or in groups. Bamboos (*M. bambusoides*) are also killed by the fungus. The fungus attacks well-spaced healthy trees in all the aspects of the plantation. The attack begins at the base of the tree or the bamboo and quickly girdles the stem round the base of the tree, it then spreads upwards until the tree or bamboo stem dies. The fungus spreads by bands of white threads running along the surface of the soil, and beneath the leaves. The white bands run from one stem to

another and branch out in all directions. The attacked portion of the wood, bark, sap and heartwood appear shining white.

There are some hundreds of acres of excellent established *gamhari** (*Gmelina arborea* Linn.) plantations at Maskumb, and the appearance of a pest of this nature is a serious matter.

Some parts of the fungus collected showed a pitted formation which it is hoped, is the fructification".

The fungus was isolated both from the decayed wood as well as from the *rhizomorphs*, but it remained sterile. From the type of spreading, fan-shaped mycelium it produced, the presence of profuse clamp connections and Mr. Dent's description, a *Basidiomycete* of the polypore type was suggested, but it was not possible to procure any fructification of the fungus.

Mortality of *gamhar* (*Gmelina arborea*, Linn.) was reported (1925) from Rajabhatkawa, Buxa division, Bengal due to attack by a fungus which also produced prominent *rhizomorphs*. In February, 1947, a tour was undertaken to survey diseases of trees and timber in the evergreen forests and teak plantations of Chittagong, Cox Bazar, and Hill Tracts divisions ; the disease was recorded in Kaptai, Sitapahar beat, Kassalong range, where besides the sterile mycelia and cord-like *rhizomorphs*, some thin poroid fructifications were collected from the dying trees and decaying slash and stools of *gamhar* (*Gmelina arborea*, Linn.) trees. The fungus was collected from the decaying logs of *gamhar* (*Gmelina arborea*, Linn.) in the virgin mixed forests of *gamhar* and evergreen hardwoods in Panchnoi beat, Batasipur range, Darrange division, Assam, during a tour in February, 1952. A report on the same fungus killing young trees of *Taraktogenos kurzii*, King. was received also from Lakhimpur division, Assam. It appears from the above that the fungus is endemic in the moist evergreen forests of the eastern part of India where it attacks various hardwoods besides *mooli* bamboos of the Hill Tracts division, Chittagong.

Pathology—In 1947 during a tour in the Hill Tracts division, Chittagong, an opportunity presented itself to investigate the pathology and to collect fertile material for the identification of the fungus. Although the plantations of Maskumb, where the disease was at its peak and had practically wiped out many acres of the forest, could not be visited, Kaptai, Sitapahar beat, Kassalong range where *gamhar* comprised 25 per cent of the crop, growing in association with *Taraktogenos kurzii* King., *Macaranga denticulata* Murrill., Arg, *Albizzia stipulata* Boiv., *Schima wallichii* Choisy, *Duabanga sonneratoides* Ham., and a large percentage of *mooli* bamboos, appeared to be equally suitable area for the study of the disease.

From the first specimen of a dying tree (Pl. I, Fig. 1) received from Maskumb plantation, the focus of infection appeared to be lodged somewhere in the collar region, approximately 6 inches above the ground, but from actual observations in the forests it was found that in most cases where the earliest stages could be detected the rot started from one or more bigger lateral roots a few inches below the surface of the soil. Due to the killing of some of the lateral roots a symptom of one-sided (lop-sided) die-back was produced on the older trees. Canker at the base of the trees was formed at a later stage when the disease advanced towards the stem. The progress of the canker in girdling the saplings and young poles appeared to be rather fast, and often with such trees the symptoms of die-back did not reach the crown, the trees wilting away all of a sudden.

During the subsequent stages as the rot advanced along the stem discolouring the thick bark, it peeled off as a dry crumbly mass and exposed the sapwood (Pl. I, Figs. 1 and 2), which gradually changed from its normal ivory white or 'pale-pinkish buff' colour to 'light-cinnamon'. In the region of attack, shrinkage cracks appeared and cubes were formed due to the quick desiccation of woody tissues. In the final stages of decay, the wood, both the sap and the heart, are stained to 'cinnamon' and due to infiltration of silky mycelia, the rot

* *Gamhari* and *gamhar* (*Gmelina arborea* Linn.) refer to the same tree.

presented the characteristic shiny appearance. In half a dozen of the diseased trees in a small area of about 1,000 sq. ft. all stages of attack could be seen. The fungus is, therefore, responsible for the fast girdling of the host and finally the formation of friable cubical rot, all stages complete within 12 months. The wilted trees of about 1 foot 6 inches to 2 feet diameter can be pulled down by pushing from one side, the decayed roots giving way from below the surface soil, the portion attached to the stem appearing as blunt processes or stubs. This also confirms that the disease starts initially from some lateral roots which are quickly destroyed before the trees are completely girdled.

The fungus behaves as Mr. Dent pointed out, both as a 'saprophyte' and as a 'primary parasite'. The change of habit, alternately as an active parasite and a powerful decaying agent was apparent during the field observations. The environmental conditions under which this species is grown in the eastern parts of India are principally responsible for the infection of healthy, well-developed and quick-growing trees. The trees die in localized areas or pockets of clayey soil which become periodically water-logged or boggy, the infection spreading therefrom to the neighbouring comparatively drier areas by the *rhizomorphs* which spread through the substratum of humus, soil, decaying plant material in the shade, and even along the long culms of living bamboos and climbers till they reach another pocket at the furthest end of the forests. The water may recede during the dry season but not before the finer rootlets have been asphyxiated and killed. It is also mentioned by Troup (1921) that *Gmelina arborea* does not thrive where the drainage is bad. In the better drained localities and on the hillsides, damage to the roots is also caused by animals such as field rats, porcupines and pigs gnawing the roots, the killed roots then taking infection. The fungus finally passes on to the dead material on the moist ground and produces fructifications in the ensuing dry weather in October and November. The hyphæ become active again when the substratum is saturated with moisture during the monsoon.

Strands of radiating fan-shaped mycelia could be found in any heap of debris, slash and litter and could be unearthed several feet below the surface of the soil (Pl. III, Fig. 2). On the surface of the decayed timber in the heaps of the debris the mycelial strands often united to form long, frequently branching cord-like *rhizomorphs* (Pl. II, Fig. 2), white to 'cream-buff' in colour, which spread through the soil and humus, often to a distance of 100 feet (Pl. IV, Fig. 1), connecting one diseased tree with another or spreading the infection ("strangling") from one tree to another (Pl. I, Fig. 1).

The strands are often formed from the extension of peg-like hyphæ beyond the hymenium. The origin of these peg-like hyphæ in this species can be traced to the sub-hymenal and also to the cortical layers of cells which form the last few layers of the context of thin resupinate sporophores (Pl. II, Figs. 1 and 2). Sometimes the mycelial strands also emerge from the context of the sporophores. Strands of mycelium have been frequently reproduced from the small pieces of sporophores fixed in upper lid of the petri-dishes for spore cultures (Pl. V, Fig. 1). In the mycelial culture long strands are often formed in the Kolley's flasks which emerge through the cotton plugs (Pl. IV, Fig. 2), and if moisture is available they even spread over the metal trays of incubators and on the glass benches in the moist chambers (Pl. V, Fig. 2).

Loss of weight of heartwood blocks of *G. arborea* after 4 months' test at 32°C.

Blocks		Loss Percentage %
Gmelina heartwood ..	Max.	15·66
	Min.	2·16
	Aver.	5·07

Blocks		Loss Percentage %
Sal sapwood	..	Max. 21·51
		Min. 3·18
		Aver. 7·55
Sal heartwood	..	Max. 16·25
		Min. 3·10
		Aver. 6·20

Cultural characters—Growth initiates as an active, sub-hyaline, cottony fringe which covers the inoculum after 24 hours. The fungus becomes vigorous after 2 days and descends on the plate as long, white cottony mycelia. After 3 days the character of the mycelia changes to cottony-silky and finally to silky. The aerial and appressed hyphæ unite and tend to form strands. The growth continues as such, except that the mycelium becomes somewhat dewy. After 6 days the hyphæ unite into tufts or strands. The character of the mycelium continues till 15 days, when due to the massing of hyphæ, at some places the mat is divided into sectors in some flasks. After 3 weeks, the fungus climbs the walls of the flask as radiating fan-shaped mycelia. After 4 weeks, the strands of hyphæ thicken further and there is fresh growth of mycelia on and around the strands.

Aerial hyphæ, hyaline, uniform, frequently branching with whorled clamp connections (Pl. VI, Figs. 7 and 8), 2 to 3/μ broad ; appressed hyphæ branching with lateral fusion and whorled clamp-connections (Pl. VI, Figs. 9 and 10), 3 to 4/μ broad ; chlamydospores present, sometimes the wall of the clamp buds thickens and are transformed into chlamydospores (Pl. VI, Figs. 11 and 12) ; also in the old mat a whole hyphæ is transformed into a chain of chlamydospores (Pl. VI, Fig. 13).

Growth on neutral malt agar media at 30–32°C. in dark.

24 hours	..	Nil
After 2 days	..	1·5 cms.
,, 3 ,,	..	2·5 ,,
,, 4 ,,	..	4·0 ,,
,, 5 ,,	..	6·0 ,,
,, 6 ,,	..	7·5 ,,
,, 7 ,,	..	9·0 ,,

Covers the plate of 12 cms. in 9 days.

Oxidase reaction—On gallic acid agar weak diffusion zone, growth 3·5 cms. ; on tannic acid agar no diffusion zone, growth nil ; on gentian violet slightly discoloured, growth good.

The *Porias* are usually regarded as slash decay, but some cause decay of timber under storage and in use. There is a wide range of variation in the behaviour of different species as regards to the reaction as a decaying agent on timber, and pathogenecity on living trees. As a decaying agent some attack softwood, others hardwoods, others both, but more commonly the former. According to the reaction, some produce white rot while others produce brown rot and some combine the reaction of both, cultures reacting both positively as well as negatively in the oxidase reactions with different media, that is the gallic acid, the tannic acid and the gentian violet agar media.

There are atleast five species of *Poria* known to attack both living and dead trees of conifers and hardwoods. *Poria subacida* (Pk.) Sacc. causes feathery white rot of conifer and hardwood slash, and also stringy butt rot on living conifers (Boyce 1944, Buckland 1946) *P. weirii* Murr. and *P. albipellucida* Baxter cause white to yellow ring rot on western red cedar (*Thuja plicata*) and attack living trees, the former causing damage in young growth and mature trees of Douglas fir in the coastal region (Mounce, Bier et all 1940, Buckland 1946) and the latter infecting the living conifer in the coastal region of British Columbia. *P. asiatica* (Pilat) Overh. which is a brown cubical butt rot fungus of conifer is also one of the major heartrot fungi of the living western red cedar on the west coast (Buckland 1946) of British Columbia. *P. obliqua* (Pers.) Karst. is a white rot fungus of broadleaved trees, and produces heartrot of living birches of Quebec, Ontario, New Brunswick of North Canada, Pennsyvania, U.S.A. (Nobles 1948) and central Europe (Bourdot et Galzin 1927). *Poria rhizomorpha*, a carbonizing rot, also behaves as a parasite of living trees.

Sporophore—Effused, thin, indistinct at the margin becomes somewhat distinct on maturity, brittle, inseparable from the substratum, colour white, dried to 'pale-pinkish buff' changing to 'light-pinkish cinnamon' with age ; pores round or angular, average 4–6 per mm., dissepiments thin 0·1–0·15 mm. ; tubes 0·5–1·5 mm., margin fimbricate ; subiculum with 2 or 3 distinct zones ; hyphæ of the subiculum continuous with the trama (Pls. VII, VIII, Figs. 1, 2 and 3) and loosely interwoven ; tramal hyphæ of two types, hyaline, fibrous with clamp connections, small lumen to almost solid, and thin, loosely interwoven hyaline, which are easily activated ; the second type of hyphæ predominates in the subiculum ; hymenium continuous over the edge of the pore wall (Pls. VII and VIII, Figs. 1, 2 and 3) ; generative hyphæ often fused giving rise to short young basidia in whorls with clamp-connections (Pl. VI, Fig. 5) ; basidia clavate, $12 \cdot 50 \times 4 \cdot 5/\mu$ (Pl. VI, Fig. 6) ; spores, hyaline, ellipsoid, $4 \cdot 0$–$5 \cdot 0 \times 2 \cdot 0$–$2 \cdot 5/\mu$ average $4 \cdot 5 \times 2 \cdot 2/\mu$; hyphal pegs simple or branched (Pl. VI, Fig. 4 and Pl. VII, hp.). The *rhizomorphic* hyphæ (Pl. VI, Fig. 3 and Pl. VII ×) are ultimately formed from thin, loosely weft subicular hyphæ from which they are gradually differentiated at different depths below the hymenium (Pl. VIII, Figs. 1, 2 and 3) ; *rhizomorphs* cord-like, colour white changing to 'pale-chamois' on drying ; hyphæ hyaline, living, branched with clamp connections, and dead, fibrous, with small lumen and short branch.

Identity of the fungus—There are two species of *Poria* which are known to produce radiating strands of *rhizomorphs* from the living mycelium, namely *Poria myceliosa* (Pk.) Sacc. and *P. albolutescens* (Rom.) Egeland. The sporophores of *P. myceliosa* are white, dried to 'warm buff' to 'clay colour' (Baxter 1929) or 'deep cream' (Lowe 1946). It is a brown rot fungus which occurs on rooted wood of conifer, rarely of deciduous trees. *P. albolutescens* occurs on wood of conifer trees and is also associated with a brown rot. *P. myceliosa* is a rare plant occurring in the Central States of U.S.A. *P. albolutescens* occurs in U.S.A., Canada, and in the countries of northern Europe. No information is available regarding the pathogenicity of these two species.

From the morphological aspects the *Poria* sp. on *G. arborea* differs much more from *P. albolutescens* than from *P. myceliosa* and with the fungus on *G. arborea* there are points of difference, namely, with the colour and with the anatomical structures of the plant that justify naming the fungus as a new species. The pores of *P. myceliosa* are bigger, 2–4 per mm. while those of this species are 4 to 6 per mm. There are differences in the size of the basidia, $3 \cdot 5$–$4 \cdot 5\mu$ in diam. and spores oblong with rounded ends to broadly oval 3–$4 \times 2 \cdot 5$–3μ in *P. myceliosa* against $4 \cdot 5$–$5 \cdot 0\mu$ diam. and spores are ellipsoid, $4 \cdot 0$–$5 \cdot 0 \times 2 \cdot 0$–$2 \cdot 5\mu$ of this fungus. The presence of the hyphal pegs in the hymenium and *rhizomorphal* pegs in the subiculum are considered to be distinctive anatomical characters in the sporophores. In addition there are two to three zones of loose hyphæ in the subiculum, which fact supports

this plant being considered to be a new species. So the name *Poria rhizomorpha* is given to this plant.

Technical Description of *Poria rhizomorpha* Bagchee

Sporophore—Effused, thin, brittle, inseparable from the substratum, colour white, dried to 'pale-pinkish buff' changing to 'light-pinkish cinnamon' with age; pores round or angular, dissepiments thin, average 4–6 per mm.; tubes 0·5–1·5 mm., margin fimbriate; subiculum with 2 or 3 distinct zones; hyphæ of the subiculum continuous with the trama; dissepiments thin, 0·1–0·15 mm.; hymenium continuous over the edge of pore wall; generative hyphæ with clamp connections; basidia clavate; spores hyaline, ellipsoid, 4·0–5·0 × 2·0–2·5/μ. The *rhizomorphs* are formed from the subicular hyphæ from which they are gradually differentiated at different depths below the hymenium; *rhizomorph* cord-like, colour white changing to 'pale-chamois' on drying.

Host—*Gmelina arborea* Linn., *Taraktogenos kurzii* King and *Melocanna bambusoides* Trin.

Habitat—The evergreen forests of North Bengal, North Assam, India and Chittagong, Eastern Pakistan.

Type deposited in the Mycological Herbarium, Forest Research Institute, Dehra Dun, India.

DIAGNOSIS

Poria rhizomorpha Bagchee, spec. nov.

Sporophorus effusus, tenuis, fragilis, a substrato haud separabilis, albus colore, in siccitate "pale-pinkish buff" ad "light-pinkish cinnamon" currente tempore mutatus; pori circulares vel angulares, dissepimentis tenuibus, mediet. 4–6 per mm.; tubi 0·5–1·5 mm., marginibus fimbriatis; subiculum 2 vel 3 zonis distinctis ornatum; subiculi hyphæ continuæ cum tramate; dissepimenta tenuia, 0·1–0·15 mm.; hymenium continuum super marginem parietum pororum; hyphæ generatrices confibulis conectentibus præditæ; basidia clavata, sporæ hyalinæ, ellipsoideæ, 4·0–5·0 × 2·0–2·5μ/. *Rhizomorphæ* formatæ ex hyphis subicularibus, a quibus gradatim distinguuntur altitudine varia sub hymenio; *rhizomorpha* funis similis, alba colore qui ætate progrediente mutatur in "pale-chamois" in siccitate.

Habitat; *Gmelina arborea* Linn., *Taracktogenos kurzii* King et *Melocanna bambusoides* Trin. In silvis semper viventibus in septentrionalibus patibus Bengaliæ atque Assamiæ, in India, atque in Chittagong, in Pakistania orientali. Typus positus in Mycolog. Herb. in Forest Research Institute, Dehra Dun.

Acknowledgements—The writer is indebted to Dr. B. K. Bakshi, Assistant Mycologist, Mycology Branch, for preparing the microphotographs, to Shri P. N. Sharma, Artist, Botany Branch for drawings and Sardar Rajendar Singh, Photographer, Silviculture Branch of the Forest Research Institute for the photographs illustrating the paper.

The writer wishes to acknowledge gratefully to Father Dr. H. Santapau, Professor of Botany, St. Xavier's College, Bombay, for very kindly translating in Latin the English diagnosis of *Poria rhizomorpha* Bagchee given in this paper.

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EXPLANATION OF PLATES

PLATE I

FIG. 1.—The base of a pole tree of *Gmelina arborea* 24 feet high, 3 feet 6 inches d.b.h., recently dead, showing rot and rhizomorphs ; the roots that were initially killed × and rotted are shown to the near side and those that are not attacked ⊙ to the far side of the camera.

FIG. 2.—The base of a young pole dying in the plantation ; showing collar rot, the cable-like rhizomorph and the initials of sporophores.

PLATE II

FIG. 1.—The fruit bodies in the process of formation on a decaying timber of *G. arborea* and the initiation of rhizomorphic strands from the sporophores.

FIG. 2.—The rot with mature fruit bodies of the fungus and rhizomorphs on decaying timber of *G. arborea*, x 1.

PLATE III

FIG. 1.—Fruit bodies on the windthrown branches of *G. arborea* crumbling away in the dry season.

FIG. 2.—A decaying timber of *G. arborea* excavated from about 3 feet under ground and washed clean and the fungus reactivated, x 1/6.

PLATE IV

FIG. 1.—Three coils of rhizomorphs consisting of cord-like structures 10–25 feet long ; two attached with the decaying timber.

FIG. 2.—Culture of the fungus on sapwood blocks of *G. arborea* in the Kolley flask.

PLATE V

FIG. 1.—Formation of rhizomorphs from the subiculum of the fruit bodies fixed on the upper lid of sterile petri-dish.

FIG. 2.—Pieces of mycelia growing on the glass benches and sterile distilled water, producing cobwebby mycelia and short rhizomorphs.

PLATE VI

TEXT FIG. 1.—Hyaline living hyphæ of the rhizomorph, x 1250.

TEXT FIG. 2.—Thick-walled to almost obliterate lumen, fibrous hyphæ of the rhizomorphs, x 1250.

TEXT FIG. 3.—Fibrous hyphæ emerging from the subiculum in the formation of the rhizomorphs, x 540.

TEXT FIG. 4.—Hyphal peg from the hymenium, x 540.

TEXT FIG. 5.—A piece of generative hyphæ showing a whorl of basidia, x 1250.

TEXT FIG. 6.—Section of hymenium showing basidia of different stages, x 1250.

TEXT FIG. 7.—Aerial hyphæ showing clamp connections, x 1250.

TEXT FIG. 8.—Aerial hyphæ showing whorled clamp connections, x 1250.

TEXT FIG. 9.—Submerged hyphæ showing whorled clamp connections, x 1250.

TEXT FIG. 10.—Submerged hyphæ showing buckled clamp connections, x 1250.

TEXT FIG. 11 and 12.—Chlamydospores from the submerged hyphæ, x 1250.

TEXT FIG. 13.—A chain of chlamydospores from the mycelia of 4 weeks' old culture, x 1250.

PLATE VII

Schamatic drawing of a section of a sporophore showing hymenial layer with basidia and hyphal pegs x subiculum (a) from which the rhizomorphs are emerging, in longitudinal and transverse sections (b) layers in the subiculum and formation of zones (c) by fusion of subicular hyphæ, x 540.

PLATE VIII

FIG. 1.—Microphotograph of a section of sporophore showing hymenial layer with basidia and hyphal pegs, subiculum from which the rhizomorphs are emerging out and layers in the subiculum and formation of zones by fusion of subicular hyphæ (stained in Haidenhain's hæmatoxylin, counterstained with Fast Green in clove oil), x 150.

PLATE VIII

FIG. 2.—Microphotograph of a section of a sporophore showing hymenial layer with basidia and hyphal pegs and loose subicular hyphæ and rhizomorph consisting of long fibrous hyphæ (stained in Haidenhain's hæmatoxyling, counterstained with Fast Green in clove oil), x 540.

FIG. 3.—The same rhizomorph as in the previous figure, x 900.

FIG. 1

FIG. 2

PLATE II

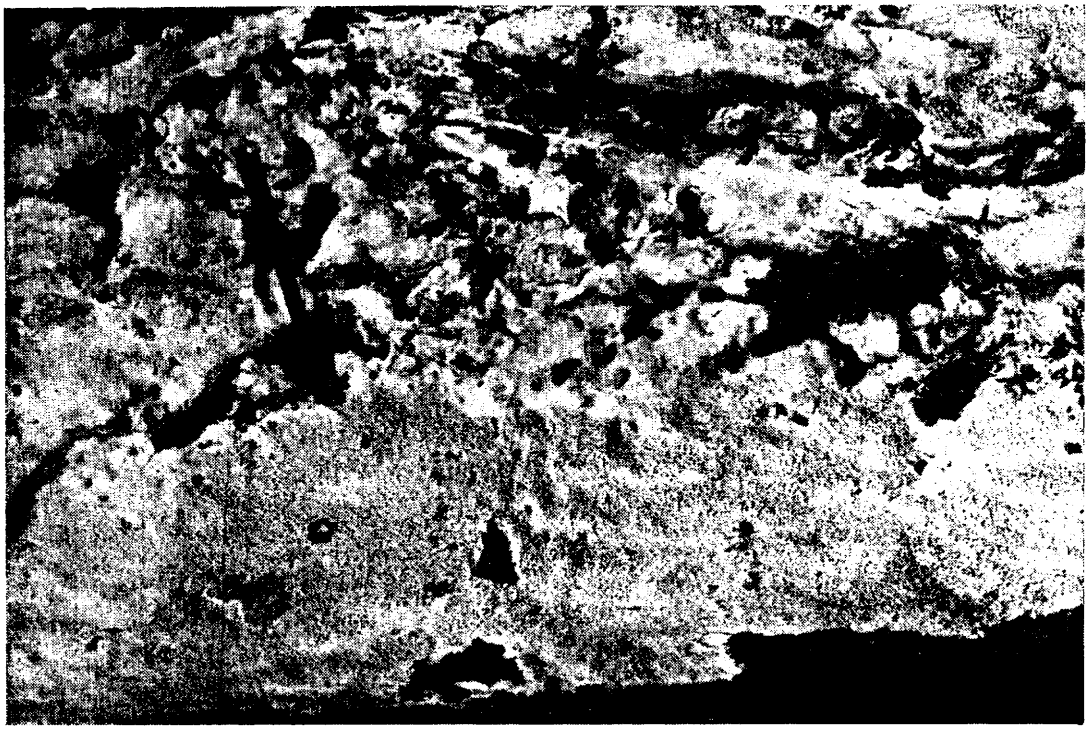

FIG. 1

FIG. 2

FIG. 1

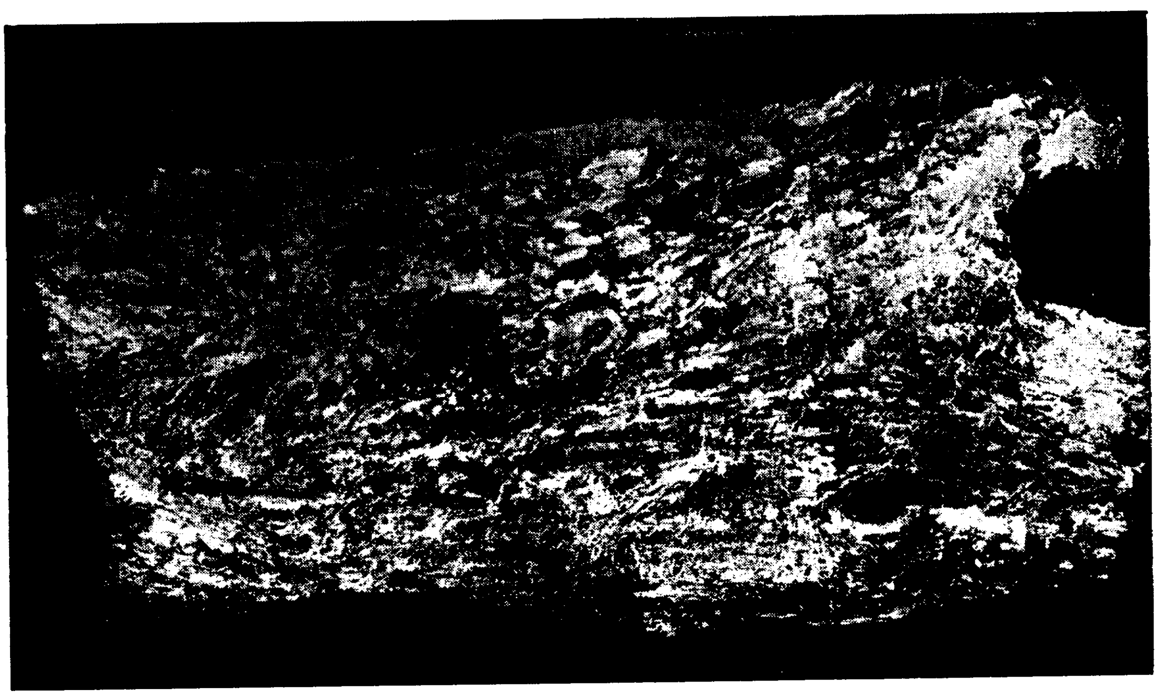

FIG. 2

PLATE IV

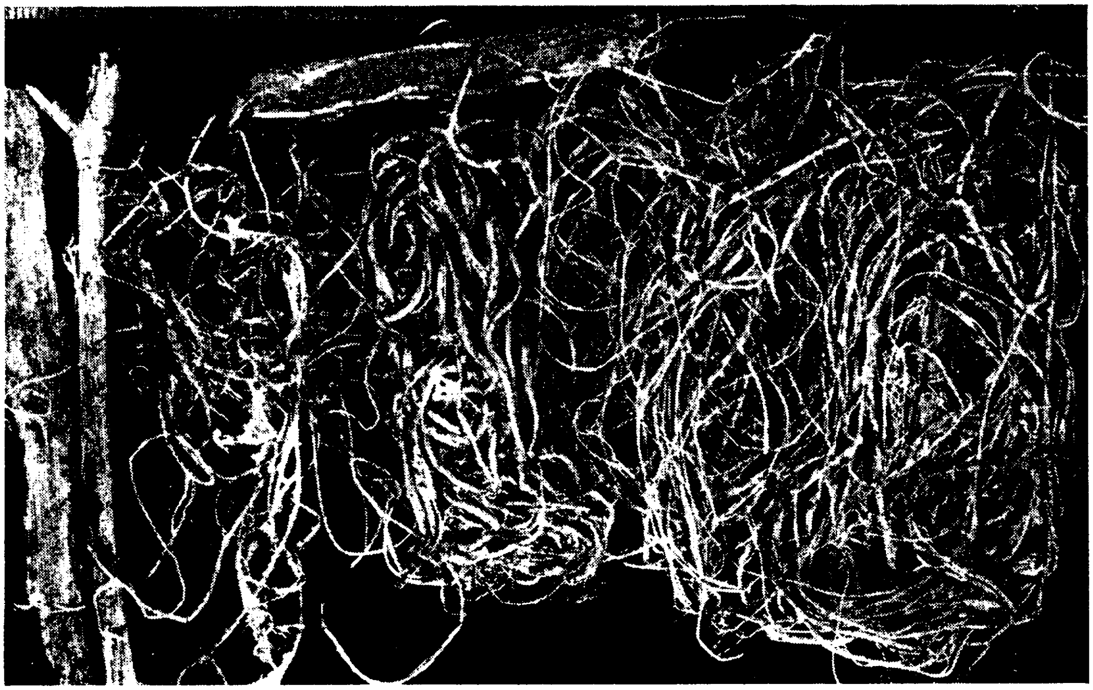

FIG. 1

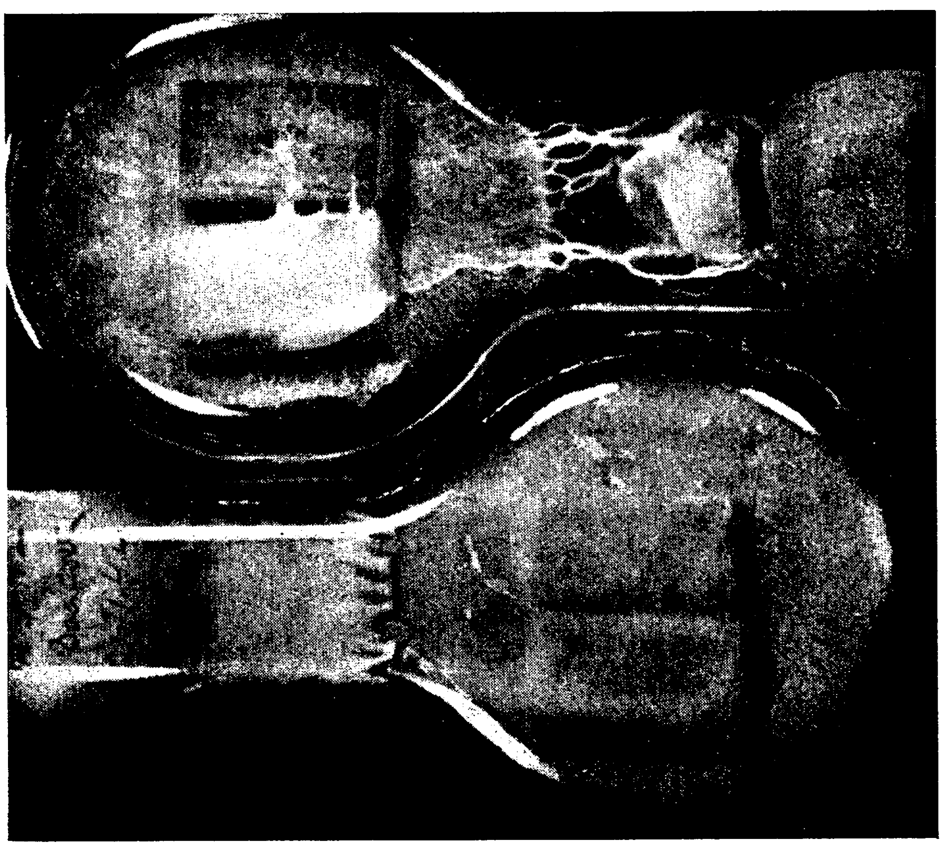

FIG. 2

PLATE VI

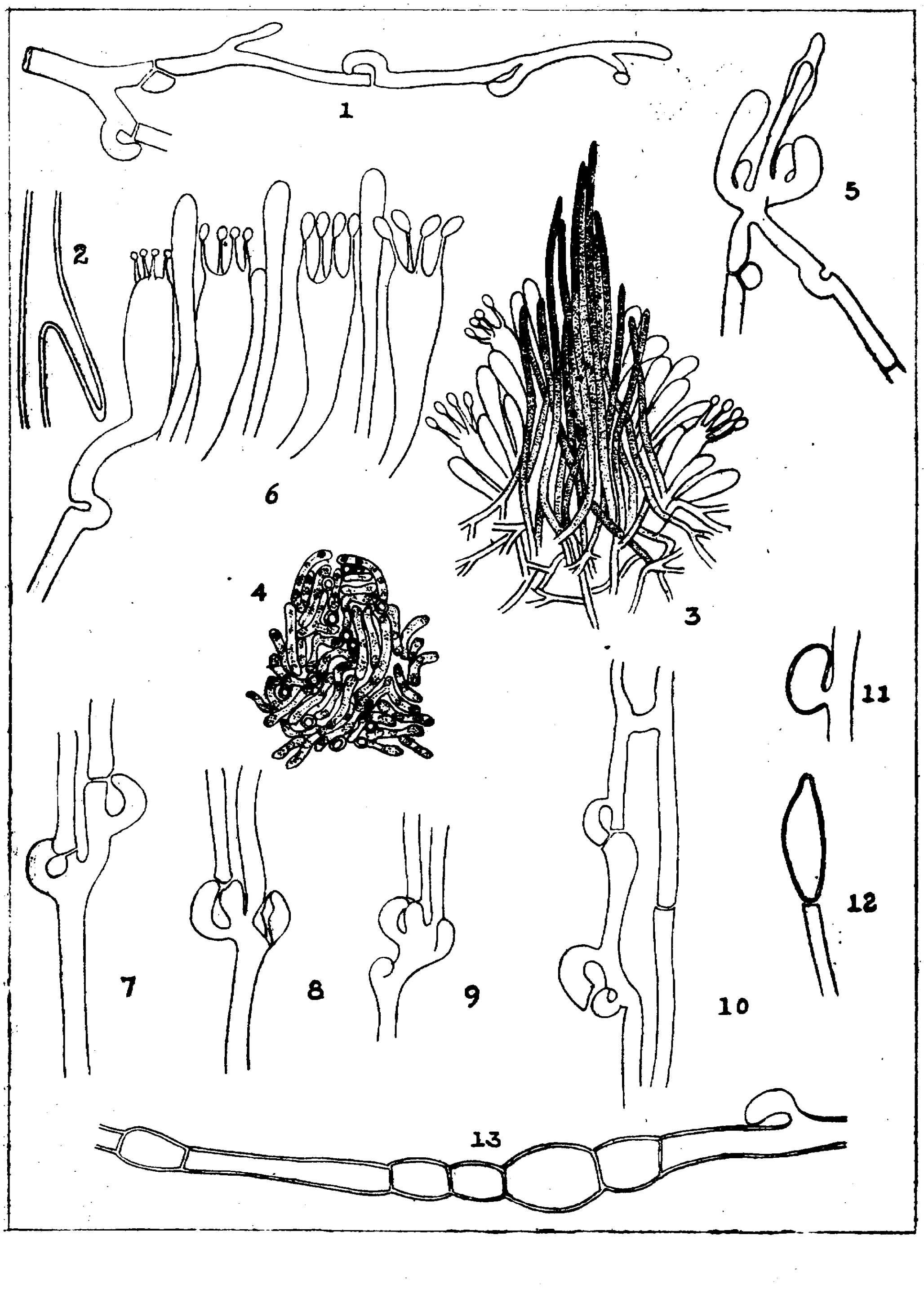

PLATE VII

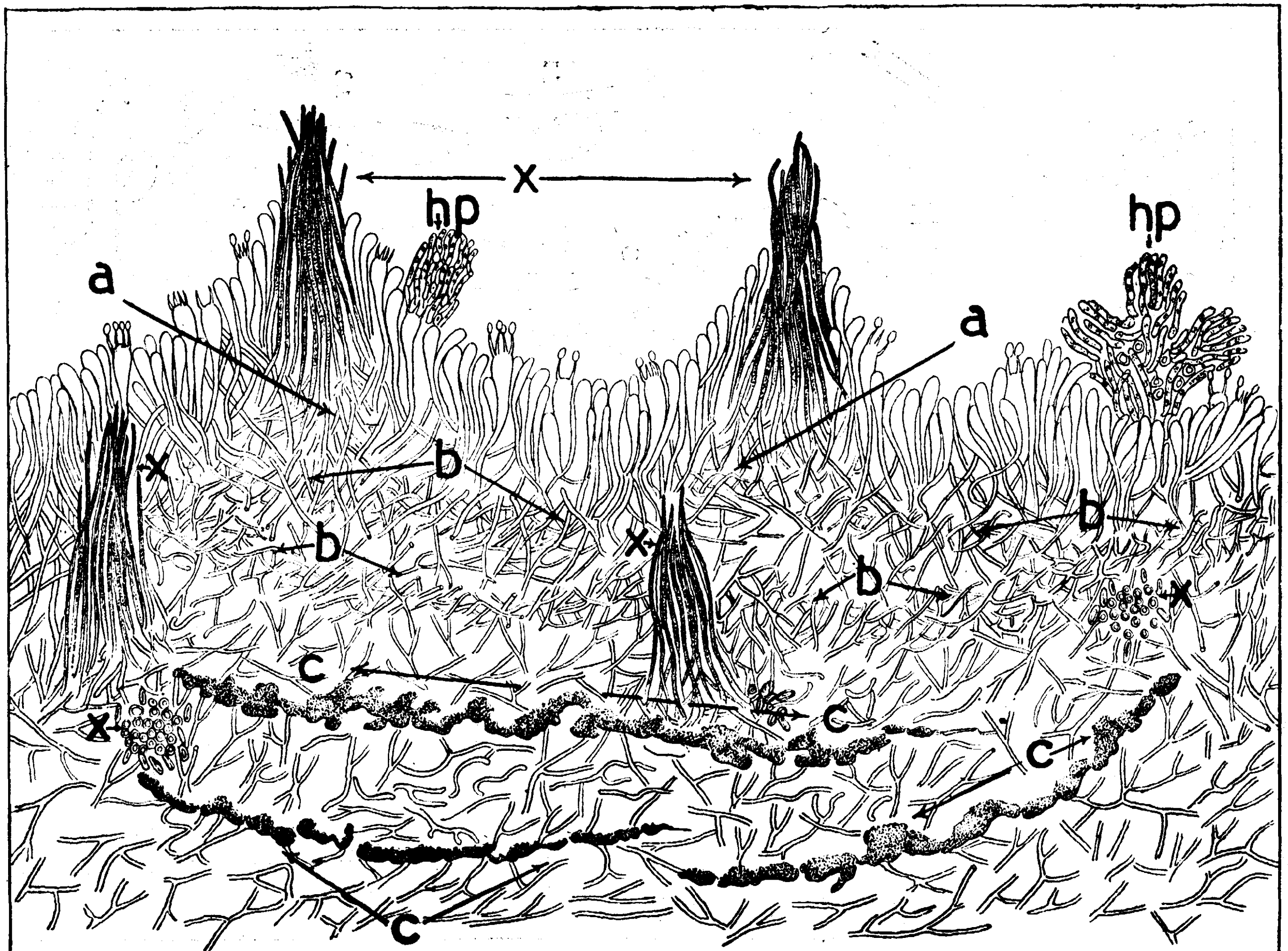

FIG. 1

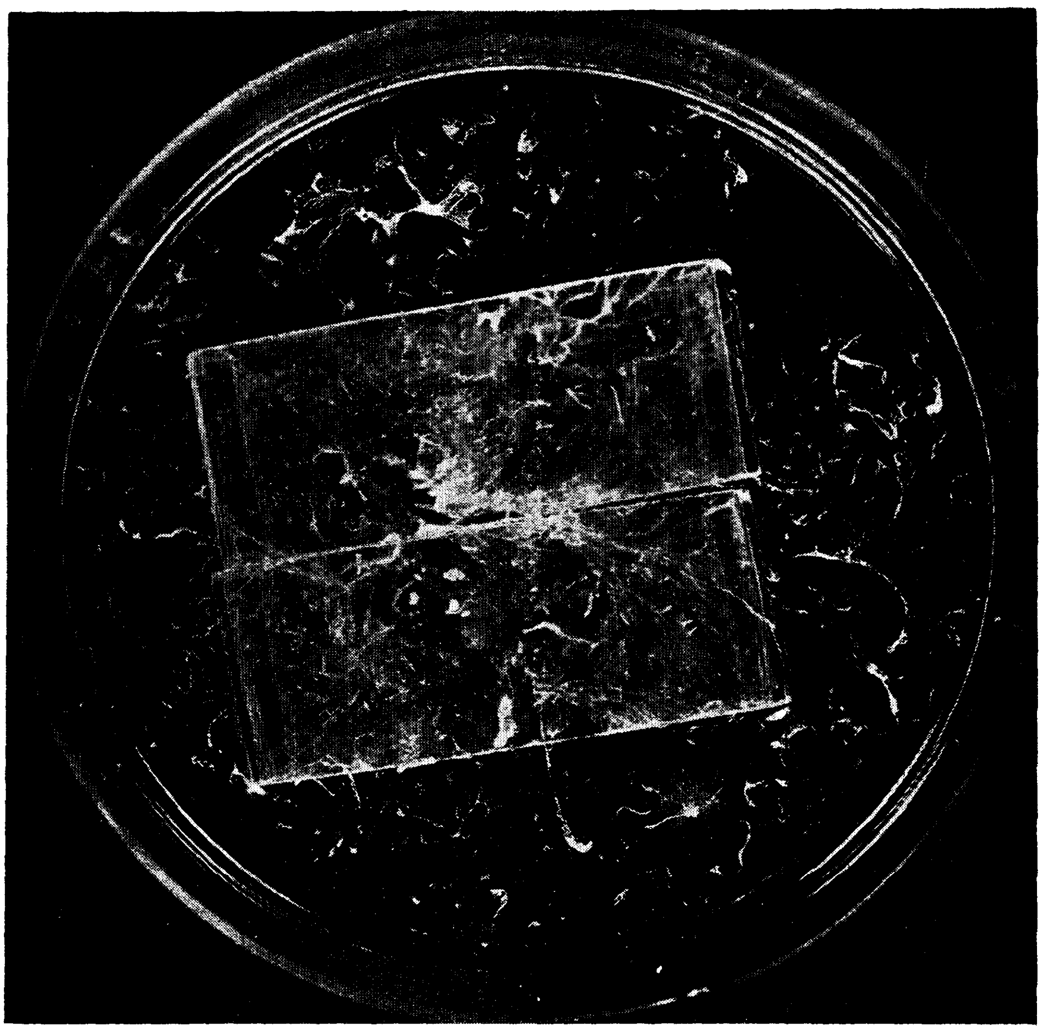

FIG. 2

PLATE VIII

FIG. 1

FIG. 2

FIG. 3

INDIGENOUS CELLULOSIC RAW MATERIALS FOR THE PRODUCTION OF PULP, PAPER AND BOARD

PART XII.—CHEMICAL PULPS AND WRITING AND PRINTING PAPERS FROM *ULLA* GRASS (*THEMEDA ARUNDINACEA*, RIDLEY)

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SUMMARY

Laboratory experiments on the chemical pulping of *ulla* grass (*Themeda arundinacea*, Ridley ; syn. *Anthistiria gigantia*, Cav.) by the soda and sulphate processes are described. Experiments were carried out on crushed as well as uncrushed grass. Results of pilot plant experiments on the production of chemical pulps and writing and printing papers are also included. A sample each of writing and printing papers made from 100% *ulla* grass pulp is appended. This investigation has shown that writing and printing papers of good quality can be prepared from *ulla* grass.

INTRODUCTION

Themeda arundinacea, Ridley, syn. *Anthistiria gigantia*, Cav., is known as *ulla* grass in some parts of Uttar Pradesh. This grass is not put to any large economic use at present. It is burnt down annually to prevent fires in forests. It is widely distributed in the sub-Himalayan tracts of Uttar Pradesh. Previous investigations carried out in this Institute on this grass dealt with the production of wrapping and packing papers[1] and pulps for straw-boards[2]. Because of its availability in large quantities in Uttar Pradesh, it was thought desirable to examine *ulla* grass for suitability for the production of writing and printing papers. The results of this investigation are described in this bulletin.

CHARACTERISTICS AND DISTRIBUTION

Bor[3] has given a description of this species. It is a tall perennial grass. The culms are 9–18 feet tall, yellow, smooth, polished and elliptic in section. The leaves are long and the sheaths are compressed and smooth. The grass flowers between October and December. It is common in low lying, well-drained soils, and is usually characteristic of sal (*Shorea robusta*, Gaertn.) forest tracts. This species grows in the lower Himalayan region from Kumaon eastwards to Assam. It is found in large quantities and in a sufficiently pure state to make cutting and extraction an economic operation in *Tarai* and *Bhabar* areas and Haldwani Forest Division of Western Circle and in North and South Kheri Forest Divisions and Pilibhit Forest Division of Eastern Circle of Uttar Pradesh. According to an estimate[1] made in 1941, a total quantity of 48,000 tons of this grass was available in these areas of Uttar Pradesh. This species is also found in Bihar, Orissa, Assam and Naga and Khasi hills.

THE RAW MATERIAL

The *ulla* grass (4 tons) for this investigation was supplied by the Divisional Forest Officer, Dehra Dun Division, at the instance of the Chief Conservator of Forests, Uttar Pradesh. The culms were greenish-yellow and the blades of the grass were brown in colour. The culms varied in length from 6 to 13 feet. About 12 culms weighed 1 lb. The moisture content of

the grass as received was about 45%. The grass was dried in the sun and used for the investigation. The culms were crushed between the rollers of the factory crusher and chopped into pieces of about 1 inch length. For the laboratory experiments the chopped grass was sieved on a sieve which had round holes of 1/8 inch diameter. For the pilot plant experiments, the chopped grass was used without sieving. For some experiments the grass was chopped without crushing.

PROXIMATE ANALYSIS

The chopped grass was converted into dust and the portion passing through 60-mesh and retained on 80-mesh was used for the proximate analysis. The results are recorded in Table I.

TABLE I

Proximate analysis of Themeda arundinacea

		% on the oven-dry basis except moisture
1.	Moisture	12·59
2.	Ash	7·41
3.	Cold water solubility	6·53
4.	Hot water solubility	10·77
5.	1% NaOH solubility	36·25
6.	10% KOH solubility	48·02
7.	Ether solubility	0·24
8.	Alcohol-benzene solubility	3·57
9.	Pentosans	22·03
10.	Lignin	31·48
11.	Cellulose (Cross and Bevan)	54·52

It is clear from the high values of the alkali solubilities that the hemicellulose content of this grass is high. The high value for the pentosans indicates that this grass is a suitable raw material for the production of furfuraldehyde. The cellulose content of this species is sufficiently high to warrant its utilization for the manufacture of pulp and paper.

FIBRE DIMENSIONS

The measurements of the length and diameter of fibres of the chemical pulps prepared by the soda process were carried out by the usual procedures followed in this laboratory. The fibres varied in length from 0·64 to 6·82 mm. with an average of 2·88 mm. The fibre diameter varied from 0·0096 to 0·0350 mm., the average value being 0·0160 mm. The ratio of the average fibre length to diameter was 180 : 1. It is known that sheet formation is good if the ratio of average fibre length to diameter is high.

PRODUCTION OF PULP

Several digestions were carried out on a laboratory scale by the soda and sulphate processes. In the soda process caustic soda was used. In the sulphate process a mixture of caustic soda and sodium sulphide in the ratio of 2 : 1 was used. The digestions were carried out

in a cast iron vertical autoclave of 3 litre capacity. The cooking liquor in the digester was brought to and maintained at the required temperature by the application of heat to the outside parts of the digester by means of gasburners.

In some experiments grass which was chopped without crushing was used. In other experiments the grass was crushed thrice between the rollers of a crusher usually used for crushing bamboo and then it was chopped and used for digestions. This was done in order to find out whether crushing of the grass would be advantageous for digestion.

After the digestion was completed, the pulp was washed free from alkali and bleached with a solution of bleaching powder. The bleaching powder was used in two stages; in the first stage about 75% of the total bleaching powder required for the complete bleaching was used and in the second stage the remainder was used. In the first stage, the bleaching operation was carried out at 35°C. and in the second stage at the room temperature. In some cases the pulp obtained after the first stage of the bleaching was treated with 2% caustic soda (on the air-dry weight of the pulp) at 70°C. for 1 hour and was washed free from alkali before final bleaching.

The bleached pulp was washed well and beaten in the Lampen Mill and used for making standard sheets on the sheet machine recommended in the Second Report of the Pulp Evaluation Committee to the Technical Section of the Paper Makers' Association of Great Britain and Ireland. The pulp sheets were conditioned at 65% R.H. and 80°F. and tested for their strength properties.

The conditions of various digestions by the soda process, the pulp yields, the consumption of bleaching powder for bleaching and strength properties of the standard pulps sheets are given in Table II and similar data for the sulphate digestions are given in Table III.

PILOT PLANT TRIALS

Three pilot plant experiments were carried out in order to confirm the suitability of *ulla* grass for the production of bleached chemical pulps and of white writing and printing papers. In two experiments the grass was crushed between the rollers of the factory crusher before chopping into pieces of about one inch length. In the third experiment the grass was not crushed before chopping. The chopped grass (about 650 lb. on the air-dry basis) was cooked with caustic soda in a vertical stationary mild steel digester of about 100 cubic feet capacity. The cooking liquor was circulated throughout the digestion through an outside tubular heater connected to the digester. After the digestion, the pulp was washed twice in the digester and then transferred to a potcher of about 350 lb. capacity (at 5% consistency). The pulp was washed well in the potcher and bleached with bleaching powder. The bleaching was carried out in two stages but without an intermediate treatment with alkali. The pulp was beaten at 5% consistency in a beater of about 350 lb. capacity. The requisite quantities of rosin size, alum and China clay were added and the stock was used for making writing and printing papers on the Fourdrinier machine at its maximum speed. This machine has a deckle of 34 inches and can be worked at maximum speed of 50 feet per minute.

The digestion conditions, pulp yields and bleach consumption of these pilot plant experiments are given in Table IV and the strength properties of writing and printing papers from these pulps in Table V. Two samples of papers are appended in this bulletin; one of them is printing paper and the other writing paper.

DISCUSSION

The results of the laboratory experiments recorded in Table II show that well-cooked pulps can be prepared from *ulla* grass by digesting the material under suitable conditions.

Well-cooked pulps are obtained under milder conditions of digestion when crushed grass is used. In the case of the crushed grass, a digestion with even 15% of caustic soda on the weight of the air-dry material at 153°C. for 4 hours gives well-cooked pulp. If the grass is not crushed, a digestion with even 17% of caustic soda at 153°C. for 6 hours yields pulp which is not entirely free from shives. Generally a slightly higher yield of bleached pulp is obtained if the intermediate alkali treatment is omitted during bleaching. This seems to be due to the removal of some alkali soluble cellulose during this treatment.

With increase in the temperature of digestion from 142°C. to 162°C. there is generally a fall in the yield of the bleached pulp and also in the strength properties of the resultant pulps. Well-cooked pulp with satisfactory strength properties is obtained if the digestion is carried out at 142°C. for 6 hours with 17% of caustic soda on the air-dry weight of the material when crushed grass is used. In the case of uncrushed grass a slightly greater quantity of alkali, e.g., 18%, is required to get a well-cooked pulp. Although a digestion with 18% of alkali at 142°C. for 6 hours yields a pulp with satisfactory strength properties though with a few bleachable shives from uncrushed grass, well-cooked pulps with slightly lower but satisfactory strength properties are obtained if the uncrushed grass is digested at 162°C. for the same period and with the same quantity of alkali.

The brightness of standard pulp sheets prepared from the pulps by the soda process was measured by means of the Photoelectric Reflection Meter Model 610 (Photovolt Corporation U.S.A.). The brightness of the sheets varied from 66 to 69 in the case of pulps in the bleaching of which intermediate alkali treatment was used and from 62 to 67 when the pulps were not treated with alkali after the first stage of bleaching. These figures for brightness are expressed on the basis of the brightness of magnesium oxide equal to 100.

The results recorded in Table III show that well-cooked pulps can also be prepared from crushed *ulla* grass by the sulphate process.

The results of the pilot plant experiments given in Tables IV and V indicate that *ulla* grass is a suitable fibrous raw material for the production of writing and printing papers. Under the conditions studied bleached pulps in yields of 37·0–40·4% on the basis of the raw material were obtained ; these yields are satisfactory for grass. The strength properties of papers are also satisfactory. There is likely to be improvement in the strength properties of papers when they are made on a commercial paper machine since the old Fourdrinier paper machine of this Institute was installed primarily for the preparation of pulp sheets and is not equipped with suitable controls for the production of papers. The satisfactory tear values of these papers is due to the long fibres of this grass. Whereas the average fibre length of sabai grass (*Eulaliopsis binata*) is about 2·0 mm. and of *Dendrocalamus strictus* (*salia* bamboo) about 3·0 mm. *ulla* grass has an average fibre length of 2·88 mm. Therefore, it should be possible to make writing and printing papers from *ulla* grass pulps without admixture with other pulps.

From the foregoing it is clear that *ulla* grass is a valuable fibrous raw material for the production of writing and printing papers. This grass is available in large quantities in Uttar Pradesh and is at present burnt down to prevent fires in forests. There is now a great demand for additional raw materials for the paper industry in this country. The prices of the chief raw materials, viz., sabai grass and bamboo, have gone up considerably. It is in the interest of paper mills, especially those situated in Uttar Pradesh and Punjab, to use this grass for the manufacture of paper.

Compared to sabai grass, *ulla* grass requires slightly more bleaching powder for the preparation of white pulps. Crushing of the *ulla* grass before digestion is desirable whereas

PRINTING PAPER

made entirely from *ulla* grass (vide Serial No. 2, Table V)

WRITING PAPER

made entirely from *ulla* grass (vide Serial No. 3, Table V)

sabai grass does not require this mechanical treatment. But the advantages in the case of *ulla* grass are the longer fibre length of the pulps, slightly higher yields of bleached pulps, and the possibility of its availability at a cheaper price.

CONCLUSIONS

1. Bleached pulps in good yields and with satisfactory strength properties can be made from *ulla* grass by the soda and sulphate processes.

2. Crushing of *ulla* grass prior to chopping is desirable as this helps to get well-cooked pulps under milder conditions of digestion.

3. As *ulla* grass pulps are long-fibred, writing and printing papers can be made from these pulps without admixture with bamboo or sabai grass pulp.

4. It should be possible for the paper mills in this country especially those located in Uttar Pradesh and Punjab to use *ulla* grass for the manufacture of white writing and printing papers.

Thanks are given to the Chief Conservator of Forests, Uttar Pradesh, and the Divisional Forest Officer, Dehra Dun, for the supply of *ulla* grass for this investigation.

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2. Bhat and Man Mohan Singh. *Indian Forest Bulletin* No. 155 (1952).
3. Bor. *Indian Forest Records* (Botany), 1941, Vol. II, No. 1, 205.

TABLE II.—*Soda digestions of Themeda arundinacea*

DIGESTION CONDITIONS AND PULP YIELDS

1	2	3	4	5	6	7	8	9
Serial No.	Total alkali as NaOH*	Consumption of alkali as NaOH	Digestion temperature	Digestion period	Alkali consumption as NaOH*	Unbleached* pulp yield	Bleach consumption as standard bleaching powder containing 35% available chlorine*	Bleached pulp yield*
	%	g./litre	°C.	hours	%	%	%	%
1	15	30	153	6	12·9	50·0	6·7	40·9
2	15	30	153	4	13·0	44·6	5·1	32·7
3	15	30	162	6	14·0	47·2	6·3	33·8
4	16	32	153†	6	13·7	43·6	4·9	33·2
5	16	32	162	6	13·3	44·4	3·6	34·7
6a	17	34	142	6	14·4	48·4	4·9	36·2
6b	17	34	142	6	14·4	48·4	5·0	33·3
7	17	34	142	6	13·1	43·1	3·5	35·8
8a	17	34	153	6	16·7	48·0	5·6	36·1
8b	17	34	153	6	16·7	48·0	6·2	38·9
9	17	34	153	6	14·0	43·1	5·1	32·6
10a	17	34	162	6	15·5	45·6	6·0	34·3
10b	17	34	162	6	15·5	45·6	7·3	35·1
11	17	34	162	6	15·1	43·1	4·3	31·5
12	17	34	162	4	15·0	43·5	4·8	31·7
13	18	36	142	6	13·1	49·2	5·0	39·7
14a	18	36	153	6	16·4	47·2	4·8	36·8
14b	18	36	153	6	16·4	47·2	5·8	39·4
15	18	36	162	6	16·1	46·8	4·6	33·3

* The % is expressed on the basis of the raw material (air-dry).
† For the first 3 hours and 162 for the remaining period.

and strength properties of standard sheets

STRENGTH PROPERTIES OF STANDARD SHEETS CONDITIONED AT 65% R.H. AND 80°F.							
10	11	12	13	14	15	16	17
Freeness of pulp	Basis weight	Breaking length	Stretch	Tear factor (Marx-Elmendorf)	Burst factor (Ashcroft)	Folding resistance	REMARKS
c.c. (C.S.F.)	g./sq. metre	metres	%			double folds	
272	62·8	8350	4·9	97·5	58·3	860	Uncrushed grass was used. Some shives were present in the unbleached pulp. Alkali *treatment during bleaching.*
267	63·7	5950	4·5	81·1	48·6	730	Crushed grass was used. Under cooked pulp containing shives. No alkali wash during bleaching.
255	64·4	7760	4·7	..	57·5	770	Uncrushed grass was used. Some shives were present in the unbleached pulp. Alkali *treatment during bleaching.*
307	57·4	7440	3·6	77·5	41·1	470	Crushed grass was used. Well-cooked pulp. Alkali treatment during bleaching.
281	60·9	6650	4·0	84·9	42·4	580	Do.
290	60·4	8500	5·0	114·2	55·3	1100	Uncrushed grass was used. Shives were present in the pulp. Alkali treatment during bleaching.
270	60·4	8980	5·0	120·0	58·8	1070	Uncrushed grass. Shives were present. No alkali treatment during bleaching.
227	62·4	8090	4·6	86·9	48·9	650	Crushed grass. Alkali treatment during bleaching. Well-cooked pulp.
270	63·2	7850	4·5	90·6	50·6	490	Uncrushed grass. A few bleachable shives. Alkali treatment during bleaching.
260	61·6	7860	4·6	93·4	50·9	..	Uncrushed grass. No alkali treatment during bleaching.
290	61·9	7220	3·8	69·0	42·9	430	Crushed grass. Well-cooked pulp. Alkali treatment during bleaching.
251	61·6	7040	4·6	99·0	50·8	590	Uncrushed grass. A few bleachable shives. Alkali treatment during bleaching.
282	61·2	6760	4·3	93·1	47·7	530	Uncrushed grass. No alkali treatment during bleaching.
319	63·2	6910	3·8	82·3	35·5	380	Crushed grass. Well-cooked pulp. Alkali treatment during bleaching.
281	63·0	6920	3·6	77·0	39·0	340	Do.
295	61·2	8170	4·5	109·5	53·3	780	Uncrushed grass. A few bleachable shives. Alkali treatment during bleaching.
252	61·6	6440	4·1	90·9	49·2	630	Do.
305	62·4	7460	4·6	92·2	51·8	580	Uncrushed grass. No alkali treatment during bleaching.
235	62·8	7920	4·6	97·9	50·4	580	Uncrushed grass. Well-cooked pulp. Alkali treatment during bleaching.

TABLE III.—*Sulphate digestions of Themeda arundinacea and strength properties of standard sheets*

DIGESTION CONDITIONS AND PULP YIELDS								
1	2	3	4	5	6	7	8	9
Serial No.	Total chemicals* (NaOH : $Na_2S=2:1$)	Concentration of chemicals	Digestion temperature	Digestion period	Consumption of chemicals*	Unbleached pulp yield*	Bleach consumption as standard bleaching powder*	Bleached pulp yield*
	%	g./litre	°C.	hours	%	%	%	%
1	16	32	153	6	15·1	47·5	6·0	37·1
2	16	32	162	4	14·2	46·7	5·0	36·1
3	16	32	162	6	15·3	41·4	7·4	34·5
4	18	36	142	6	16·0	47·5	6·3	36·9
5	18	36	153	6	16·7	46·5	5·2	37·2
6	18	36	162	6	16·3	45·8	4·7	31·9
7	20	40	142	6	17·8	44·9	4·9	36·5
8	20	40	153	4	16·7	44·4	4·4	33·0

* The % is expressed on the basis of the raw material (air-dry).

crushed grass was used for digestions. Intermediate alkali treatment was used during bleaching

STRENGTH PROPERTIES OF STANDARD SHEETS CONDITIONED AT 65% R.H. AND 80°F.

10	11	12	13	14	15	16	17
Freeness of pulp	Basis weight	Breaking length	Stretch	Tear factor (Marx-Elmendorf)	Burst factor (Ashcroft)	Folding resistance	REMARKS
c.c. (C.S.F.)	g./sq. metre	metres	%			double folds	
310	63·9	7020	3·4	66·5	38·1	360	Well-cooked pulp.
234	55·4	6750	4·1	73·2	52·2	1360	Do.
224	62·4	7220	3·5	72·2	44·7	760	Do.
215	63·3	6940	3·3	56·5	44·9	520	A few bleachable shives.
215	63·4	7100	3·6	56·8	39·1	340	Well-cooked pulp.
308	63·9	6490	3·7	84·9	35·7	770	Do.
331	60·2	6340	3·3	78·9	48·5	520	Do.
266	62·1	7060	3·5	89·2	39·9	700	Do.

TABLE IV.—PILOT

Soda digestions of ulla

1	2	3	4	5	6
Serial No.	Total chemicals*	Concentration of chemicals	Digestion temperature	Digestion period	Consumption of chemicals*
	%	g./litre	°C.	hours	%
1	17	28·3	153 for the first hour and 142 for the remaining period	6	15·1
2	17	28·3	162	6	16·2
3	20	33·3	162	6	18·2

* The % is expressed on the basis of the raw material (air-dry).

TABLE V.—PILOT

Strength properties of papers from pulps described in Table IV, Serial Nos. in this Table

1	2	3	4	5	6		7		8	
Serial No.	Freeness before the addition of size, etc.	Ream weight 20" × 30" — 500	Basis weight*	Thickness	Tensile strength (Schopper)		Breaking length*		Stretch	
	c.c. (C.S.F.)	lb.	g./sq. metre	mils (1/1000 inch)	kilograms breaking strain for 1 cm. width		metres		%	
					Machine direction	Cross direction	Machine direction	Cross direction	Machine direction	Cross direction
1	200	28·9	62·7	3·90	2·75	1·48	4390	2360	2·0	2·8
2	160	31·4	68·6	2·95	2·95	1·51	4300	2200	1·7	2·8
3	160	23·6†	67·4	3·50	3·00	1·45	4450	2150	1·5	3·0

* For calculating this, oven-dry weight of the paper was used.

† Weight of a ream, 17" × 27" — 500.

PLANT TRIALS

grass and pulp yields

7	8	9	10
Unbleached pulp yield*	Bleach consumption as standard bleaching powder*	Bleached pulp yield*	REMARKS
%	%	%	
..	6·8	40·4	Crushed and chopped grass was used. Well-cooked pulp was obtained. This pulp was used for making printing paper.
44·0	6·3	37·0	Crushed and chopped grass was used. Well-cooked pulp was obtained. This pulp was used for making printing paper.
42·6	6·4	40·4	Uncrushed but chopped grass was used. Well-cooked pulp was obtained. This pulp was used for making writing paper.

PLANT TRIALS

correspond to the Serial Nos. in Table IV. The papers were conditioned at 65% R.H. and 85°F.

9		10		11	12	13		14
Tearing resistance (Marx-Elmendorf)		Tear factor*		Bursting strength (Ashcroft)	Burst factor*	Folding resistance (Schopper)		REMARKS
g.				lb./sq. inch		double folds		
Machine direction	Cross direction	Machine direction	Cross direction			Machine direction	Cross direction	
45·3	57·4	72·2	91·5	19·5	21·9	26	10	Printing paper.
43·0	45·6	62·7	66·5	19·7	20·2	9	9	Printing paper.
41·0	42·2	60·8	62·6	19·7	20·6	9	10	Writing paper.

INDIAN BELLADONNA

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Introduction—Forests in India provide hundreds of medicinal plants, some of which are *pharmacopœial*, while others are used in indigenous medicine. Most of these drugs are collected by petty leaseholders and contractors whose methods are often wasteful, and the quality of whose collections is usually poor. It is only in a few cases that a systematized and controlled collection is made with the result that many of our drugs have come into disrepute on account of the haphazard collection at wrong seasons, non-grading and improper care in drying and storage. Often, the greed for bigger gains has led to adulteration, and many an otherwise valuable product has lost trade connections in foreign markets. It is, therefore, a matter of great concern that production of raw materials of reliable quality has not kept pace with the increasing demands both in the home and foreign markets. Except in a few cases, exploitation of these products has resulted from the stress of demand ; there has seldom been any planned action behind it. If this state of affairs continues, it is bound not only to affect the trade and industry but also the health of the population adversely. The remedy lies in improving the knowledge of collectors and in the adoption of measures to ensure the collection and sale of medicinal plants of standard quality.

In a number of cases the plants grow scattered in forests in difficult or inaccessible places, and it is difficult to collect or to supervise the collection of standard quality. They do not often possess the requisite amount of the active principles for which they are prized. For these and other reasons it is desirable that they should be brought under cultivation, so that a sufficiency of supply of products of standard quality could be maintained. It must, however, be borne in mind that cultivation of medicinal plants for commercial purposes is far more complicated than ordinary agriculture. In this case the "yield and quality" have a wider significance. For instance, the word quantity is not limited to obtaining the maximum yield per acre, but includes a wide field of work aiming at the improvement of individual constituents of importance, such as alkaloids, glycosides and essential oils, in the maximum quantity. Many gaps still exist in our information regarding the cultural needs of many of the species, and these will have to be filled by systematic and careful investigation involving selection of strains and study of environmental factors and manurial needs.

The need for suitable publications for the use of collectors, dealers, traders, cultivators and others interested in Indian medicinal plants has long been felt in India. The present note deals with *Atropa acuminata* Royle *ex* Lindl. (Indian belladonna), its Indian names, botanical characters including pharmacognostic features, distribution, uses, parts used in medicine, their preparations, adulterants and substitutes, cultivation, collection, preparation for the market, markets and prices, etc. It is hoped that this will result not only in the better utilization of the existing resources of this important medicinal plant, but will also help in increasing the supplies of a better quality of leaves and roots through cultivation.

Botanical Name—Atropa acuminata Royle *ex* Lindl.†

Trade Name—Indian belladonna.

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* Now transferred to the Botany Branch.

† The Indian belladonna plant was hitherto known as *Atropa belladonna* Linn. But *A. belladonna* is the name of the European plant, and it differs considerably from the Indian plant. At one time the Indian belladonna was referred to as *A. lutescens* Jacquem, but it is now agreed that Indian belladonna should be called *A. acuminata* Royal *ex* Lindl. However, Youngken *et al.* (1948), as a result of their detailed pharmacognostical study of Indian and European belladonna, conclude that the former does not show sufficient variation to deserve a specific rank. They, therefore, suggest that, instead of referring to the Indian plant as *Atropa acuminata* Royal *ex* Lindl., it should be called *Atropa belladonna* Linn., var. *acuminata*.

Atropa acuminata

Indian Names—Bengal – *Yebruj* ; Bombay – *Girbuti* ; Hindi – *Sagangur*, *Angurshefa*, *Lukmuna* ; Kashmir – *Mait-brand* ; Punjab – *Suchi*, *Angurshefa*.

Botanical Characters—A tall straight perennial plant, 3–6 feet high, with large simple leaves and greenish-yellow, bell-shaped flowers.

Leaves stalked, exstipulate, alternate, entire, elliptic or ovate-lanceolate, tapering at both the apex and base, 3–6 inch long and 2–4 inch broad ; the second and third lateral veins of the leaves make with the midrib usually an angle of 30° to 40°. In the axils of the upper leaves there is usually a short branch bearing one or several small leaves.

Flowers shortly stalked, bell-shaped, greenish-yellow, $\frac{3}{4}$–1 inch long and $\frac{3}{4}$ inch in diameter, borne singly or in groups of 2–4 in the axils of leaves.

Fruit a black or purple-black globose, shining berry of the size of cherry ($\frac{3}{4}$ inch in diameter) and surrounded at the base by the spreading calyx.

Seeds many in a fruit.

Indian belladonna differs from the European belladonna (*Atropa belladonna* Linn.) by its more acuminate leaves with the lateral veins in their general direction making a more acute angle with the midrib, and yellowish-green flowers with larger floral organs. The flowers are yellowish-purple in European belladonna.

Distribution—Belladonna grows in the Western Himalayas at an altitude of 6,000 to 11,000 feet from Kashmir to Simla. In Jammu and Kashmir state it is found in Bhadharwah and Kishtwar forest divisions, Gulmarg, Pir Panjal range, Lolab valley forests, Kamraj forest division, Kishenganga valley, Langet, Rajwar forests and Sind valley. In Chamba it occurs in the Khangu reserve forest. It is also found in Kulu forest division, in Kunawar and in Narkunda forests of Simla hills.

Parts used as Drug—Belladonna is used in medicine in two forms. Belladonna folium (belladonna leaves) and belladonna radix (belladonna roots). The former is mainly used in the preparation of medicines for interal use, and the latter in the preparation of galenicals meant for external application.

A. *Belladonna folium*—Belladonna folium consists of the dried leaves or leaves and other aerial parts collected when the plant is in flower. The drug possesses slight odour and somewhat bitter and acrid taste.

a. *Macroscopical characters*—Drug is identified, when its leaves are slightly broken, by the characters of the leaves, flowers and fruit as given above under the heading "Botanical characters". Further, the dried leaves are pale-green to brownish-green and the upper side darker-green than the lower. A few flowers and fruits may also be found. If the leaves are broken the most useful diagnostic characters are :—

(*i*) *The arrangement of veins in leaf*—The main lateral veins in their general direction make a more acute angle than is the case in the European belladonna.

(*ii*) *Roughness of the leaf surface*—This is due to the presence of calcium oxalate crystals in some of the cells of the leaf.

b. *Microscopical characters*—A transverse section of the leaf and young stem show the following characteristics :—

(*i*) *Leaf :*

Epidermis, cells have wavy walls and a striated cuticle.

Stomata, of solanaceous type are present on both surfaces, but are common on the lower.

Hairs : *Clothing hairs,* simple and more numerous on young leaves. They are uniseriate with smooth outer walls. *Glandular hairs,* some have a unicellular glandular head while others a short pedicel and a multicellular glandular head.

Crystals, Microsphenoidal crystals, of calcium oxalate are found in certain of the cells of the spongy mesophyll.

Mesophyll, made up of a single palisade layer and several layers of spongy parenchyma.

Midrib, convex above and shows an arc of bicollateral vascular bundles. A zone collenchyma lies under epidermis.

(*ii*) *Young stem :*

Sections of the stem 2·5 to 3·0 mm. in diameter show the following characteristics :—

Epidermis, consists of small square to slightly tangentially elongated epidermal cells, with a striated cuticle, and beaded vertical walls, and showing numerous uniseriate, non-glandular hairs, many up to 5 celled, a few up to 6 celled, also numerous glandular hairs with up to 5 celled, uniseriate stalks and small subspherical to spherical heads. Numerous stomata of the solanceous type are present.

Cortex, consists of about 6 layers of chlorophylloid collenchyma.

Pericycle, consists of 2 or 3 layers of starch and microcrystal-bearing parenchyma in which are scattered pericyclic fibres.

Vascular tissue, consists of many bicollateral fibrovascular bundles.

Pith, consists of richly protoplasmic, pitted parenchyma, many of the cells containing masses of microcrystals.

(*iii*) *Powdered leaf* :

The powdered leaf is green in colour. Under the microscope the powder shows fragments of epidermal cells with wavy walls and striated cuticle ; solanaceous type stomata ; clothing hairs, uniseriate with smooth outer walls ; glandular hairs few, some resembling the clothing hairs but having a unicellular gland, others having a pedicel and a multicellular gland ; fragments of mesophyll containing calcium oxalate crystals ; fragments of flower and fruits ; pollen grains ; fragments of stem tissue with lignified pericyclic fibres and wood fibres and large vessels.

c. *Quantitative microscopic measurements of Indian and European belladonna leaf*—The numerical values in the following table indicate differences between Indian and European belladonna.

Value	Indian belladonna (*A. acuminata*)	European belladonna (*A. belladonna*)
Average palisade ratio	8·3	6·1
Vein islet number	10·0	—
Stomatal number per sq. mm.		
Upper epidermis	14·0	10·1
Lower epidermis	93·2	131·1
Stomatal index		
Upper epidermis	3·4	2·9
Lower epidermis	17·6	17·6

B. *Belladonna radix*—Belladonna radix consists of dried root or root and rootstock. The drug possesses slight and characteristic odour ; sweetish then slightly bitter taste.

a. Macroscopical characters—Roots found in commerce are in cylindrical pieces up to 3 cm. in diameter often contorted or longitudinally fissured. Most of the samples consist of root with the rootstock (diameter 3 to 9 cm.) still attached and bearing the bases of 4 to 12 aerial stems of 1 to 2 cm. in diameter and hollow. The roots are with short fracture and they are externally pale brownish-grey in colour.

b. Microscopical characters—The transverse sections of the root, rootstock and stem base exhibit the following characteristics.

(*i*) *Root :*

Bark, rather dark, about 1 mm. thick, surrounding a yellowish-grey woody core consisting of a central solid cylinder of porous xylem and cellulosic tissue.

Cork, cells are brownish in colour and consist of several layers. Dimensions from measurement of 270 cells, length 34–60–130–200 μ mean 95 μ, standard deviation 34 μ ; width 20–32–56–86 μ mean 44 μ, standard deviation 12 μ. The number of cork cells, per sq. mm. calculated from counts of 25 fields of about 0·1 sq. mm. were 167 to 225 to 345 to 400 ; mean 285. A statistical analysis of the figures show that the mean of 10 such counts will fall within the range of 227 to 344 cells per sq. mm. It may be considered that if the mean of 10 such counts is taken, a value below 344 indicates *A. acuminata* and above 347 indicates *A. belladonna*.

Phellogen, not readily distinguishable.

Phelloderm, made up of 10 layers of cells, and in addition to starch, some cells contain a reddish-brown resinous substance.

Secondary phlœm, consists of about 30 to 50 layers of cells, mainly starch-bearing parenchyma, radical groups of sieve tissue, a few isolated fibres with associated groups of collapsed sieve tissue, numerous lignified fibres and fibrous cells isolated or in groups of up to 4. Fibrous cells length, 140 to 250 to 400 to 500 μ diameter about 15 to 40 μ.

Cambium, consists of about 4 layers of collapsed cells.

Secondary xylem, in young roots is made up of cellulosic starch-bearing parenchyma with strands of 3 to 10 vessels and associated trachieds ; fibres and lignified parenchyma. Older roots exhibit up to about 4 wide concentric cylinders of vessel strands separated by narrow cylinders of cellulosic parenchyma and interxylary phlœm. The vessel elements are somewhat longer, the fibres more numerous, frequently with bifurcate tips and somewhat longer than in *A. belladonna*.

Primary xylem, is a central solid diarch strand.

Medullary rays, at the cambium about 5 to 7 per mm. arc ; in tangential view elongate spindle shaped, up to 20 cells high and 1 to 5 cells wide.

Starch, occurs abundantly in all the cellulosic tissues ; the grains simple or of two or rarely three components.

Calcium oxalate crystals, occur in all the cellulosic tissues as microsphenoidal crystals in scattered idioblasts.

(*ii*) *Rootstock :*

Cork, is composed of 3 to 8 layers of cells similar in appearance and in dimensions to those of the root. The mean number of cells per sq. mm. calculated from 10 counts was 275.

Phelloderm, is composed of cells forming prominent files separated by large intercellular spaces, with occasional scattered moderately thick-walled lignified simple pitted cells.

Pericycle, consists of 1 to 3 layer, of parenchyma with occasional similar fibres, isolated or in groups of 2 or 3, length 1500 to 2400 μ.

Secondary phlœm, is similar to that of the root. Fibres and fibrous cells length, 180 to 220 to 450 to 560 μ.

Secondary xylem, consists of 3 to 5 cylinders composed of vessel strands and associated tracheids, fibres and lignified parenchyma, separated by partly lignified medullary rays in all but the innermost cylinder in which the rays are completely lignified. Tissues composing the secondary xylem are similar to those of the root with the exception of vessel elements and the fibres which are both shorter. Vessel elements length, 80 to 125 to 250 to 350 μ. Fibres length, 320 to 350 to 550 to 780 μ.

Medullary rays, at the cambium, 1 to 3 per mm. arc ; in tangential view elliptical, 4 to 12 to 36 to 50 cells high and 2 to 5 to 15 to 20 cells wide, becoming wider towards the outer limit of the secondary phlœm. Cells similar in form to those of the root.

Perimedullary phlœm, occurs in radial strands with accompanying groups of 1 to 5 fibres, adjoining the inner border of the xylem.

Pith, sometimes with a central cavity.

Starch and calcium oxalate crystals, similar in both characters and distribution to those of the root.

(*iii*) *Stem base :*

Epidermis, consists of 1 to 2 layers of isodiametric thin-walled cells often with a tangential partition wall. Some specimens show 1 to 3 layers of cork cells produced by 1-or 2-layered phellogen. Cells of both tissues are similar to those in the root.

Cortex, composed of about 20 layers of axially elongated starch-bearing parenchyma with intercellular spaces.

Endodermis, composed of 1 to 2 layers of thin-walled ellipsoidal parenchyma with flattened surfaces of contact, and without intercellular spaces, some cells having a thin tangential dividing wall.

Pericycle, consists of 1 to 3 layers of axially elongated elliptical to flattened thin-walled parenchyma with numerous groups of 1 to 6 fibres. Fibres septate and mostly shorter than *A. belladonna* fibres, length 350 to 450 to 1050 to 1650 μ.

Secondary phlœm, composed of 7 to 15 layers of cells similar to those of the root.

Cambium, similar to that of the root.

Secondary xylem, dense cylinder of lignified tissue with an undulate inner border ; composed of 40 to 50 layers of fibres with scattered radial vessel strands (of 2 to 10 vessels with accompanying trachieds and lignified xylem parenchyma) and traversed by numerous straight medullary rays. Dimentions-length of vessel elements 100 to 125 to 250 to 330 μ and length of fibres 230 to 330 to 520 to 670 μ.

Medullary rays, at the cambium, about 5 to 6 per mm. arc ; in tangential view narrow, tapering, about 2 to 7 cells wide and about 4 to 18 cells high.

Perimedullary phlœm, sieve tissue similar to that of the secondary phlœm ; fibres in groups of 5 to 7, similar to those of the pericycle.

Pith, cells form a loose network surrounding large intercellular spaces.

Starch, similar in both characters and distribution to that of the root.

Calcium oxalate crystals, similar to those in the root.

(*iv*) *Powdered root :*

The powdered root is grey to light-brown in colour. Under the microscope the powder shows numerous starch grains with diameter 3 to 6 to 15 to 30 μ ; fragments of parenchyma containing crystals of calcium oxalate; fragments of cork ; fragments of vessels with close arranged pits ; xylem fibres and tracheidal fibres.

c. *The characters by which Indian belladonna root may be distinguished from that of European belladonna* (*A. belladonna*).

1. The cork cells are longer and the number per unit area is less ; a mean value of less than 344 cells per sq. mm. calculated from 10 fields of about 0·1 sq. mm. indicates Indian belladonna and of over 347 cells per sq. mm. indicates *A. belladonna.*
2. Fibres and fibrous cells occur in the secondary phlœm.
3. The vessel elements are longer.
4. The xylem fibres are long and more numerous.
5. Starch grains of more than three components are absent.

Chemical constituents—European belladonna contains several alkaloids, chiefly *l* — hyoscyamine and small amounts of *l* — hyoscine and optically inactive atropine (*dl* — hyoscyamine). In addition, there are small quantities of volatile bases, such as pyridine and N methyl — pyrroline which do not possess the therapeutic activity of hyoscyamine, and, if not removed by heating during the assay of the drug, will finally appear as hyoscyamine. It also contains B — methyl — aesculetin (scopoletin), succinic acid, asparagin, etc. The constituents of the Indian belladonna closely resemble those of the European species. In the case of Indian roots, however, a larger proportion of volatile bases is found and, therefore, special precautions should be taken when assaying Indian belladonna.

There is a great variation in alkaloidal content due to climate, soil and age of the plants. The alkaloids are most abundant in metabolically active tissues. The alkaloidal content (chiefly *l* — hyoscyamine) of dried European belladonna leaves may vary from 0·25 to 0·9 per cent, with an average of 0·4 per cent, and that of dried roots from 0·3 to 1·0 per cent (usually 0·4 to 0·6 per cent). According to Denston (1948), the alkaloidal content (chiefly *l* — hyoscyamine) of the leaves of Indian belladonna varies from 0·13 to 0·78 per cent with an average of 0·45 per cent, and that of the dried roots from 0·29 to 0·8 per cent with an average of 0·47 per cent. But, according to Chopra and Ghose (1926), the alkaloidal content in the Himalayan plant is 0·5 per cent in leaves and 0·81 per cent in roots. According to a recent publication (Chopra *et al.*, 1946) as much as 0·94 per cent of total alkaloids have been reported from the leaves of Indian belladonna collected from Kashmir in August at a time when the plant begins to flower. Youngken *et. al.* (1948) also report that leaves, roots and berries of the Indian belladonna possess a higher alkaloidal content, calculated as hyoscyamine, than in the case of the European belladonna.

The quantity of the alkaloids present in the plant depends on various factors. In the subaerial portion of the plant in the fresh coı dition, the seeds, the ripe fruits and the leaves contain the largest amount of alkaloids, while in the dry state the unripe fruit, the leaves and the ripe fruit are richest in descending order. Young leaves have a higher percentage of alkaloidal content than the mature leaves. There is a strong evidence to support that in the actively growing plant atropine is absent, but as the plant becomes less vigorous some of the *l* — hyoscyamine is recemized to atropine. Recemization also occurs if the drying process is protracted,

and, in order to ensure the presence of the more active l — hyoscyamine, the actively growing tops should be carefully and quickly dried immediately after collection. According to Rowson (1945), a maximum of 153 per cent increase in the alkaloidal content of a 2nd year tetraploid has been obtained with an average increase of 93 per cent. He obtained tetraploid plants or branch chimeras by treating belladonna seeds or stem apices by colchicine. Such plants were characterized by having in each cell nucleus twice the number of chromosomes present in the normal diploid plant ($2n = 72$). This shows that the chromosome number of the nucleus has an influence upon the potentiality of the plant for alkaloidal production.

Cromwell (1943) showed that the alkaloid hyoscyamine could be biosynthesized in *A. belladonna* by the use of various amino acids and related amines. Youngken *et al.* (1948) using Cromwell's method report that no significant increase of the alkaloidal content was noted following the injection of certain amino acids in the plant tissues of both the Indian and European belladonna.

Uses—Although belladonna and its active principles, the alkaloids hyoscyamine and atropine, are largely used in Western medicine, it is remarkable that, despite plentiful occurrence of Indian belladonna in the Western Himalayas, the medicinal virtues of this important plant escaped the notice of the ancients of India who had specialized in the study of herbal cures. This plant, is, therefore, not used in indigenous medicine. In Western medicine belladonna and its active principles are commonly used as a sedative, antispasmodic, anodyne, and as a mydriatic in diseases of the eye. They are also valuable antidotes in cases of poisoning with opium and muscarine. Belladonna reduces secretions from secretory glands, relaxes spasms of involuntary muscles and accelarates the heart rate. It is used to decrease excessive secretions of the sweat, salivary and gastric glands. It acts as a powerful antispasmodic in intestinal colic and, given with purgatives, it allays griping. It is, therefore, of great service in lessening the pain and allowing the passage of the intestinal contents in various forms of colic. By relaxing the muscles of the bronchioles, it acts as a valuable relief in spasmodic asthma, and since it is well tolerated by children, it is given in appropriate doses in the treatment of whooping cough. It is also used in the treatment of urinary incontinence and for the relief of spasm associated with biliary and renal colic. The properties of the roots essentially resemble those of the herb, but the former is used chiefly for external application. Belladonna liniment, plaster and ointment have long enjoyed a considerable application as local anodynes, especially in the treatment of intercostal neuralgia and lumbago, and to relieve the pain of pleurisy. Belladonna plasters of suitable shape, applied to the lactating breast, allay the pain of distension and are thus reputed to decrease the secretion of milk. Belladonna plaster should not, however, be applied to broken skin. Linimentum belladonnæ cum chloroformo is suitable for application to the skin on flannel to relieve neuralgic pain. Belladonna suppositories are used to relieve neuralgic pain and spasm of anal fistula. Atropine and hyoscamine have the property of dilatation of the pupil and are largely used in ophthalmology as a means of diagnosis and treatment.

Purity standard—Indian belladonna is as efficaceous as the European belladonna and is, therefore, included in the British Pharmacopœia. The following are the purity standards :—

Leaf drug :	1.	Alkaloids of belladonna leaf calculated as hyoscyamine	Not less than 0·3 per cent
	2.	Acid insoluble ash	Not more than 3·0 per cent
Root drug :	1.	Foreign organic matter	Not more than 2·0 per cent
	2.	Alkaloids of belladonna root calculated as hyoscyamine	Not less than 0·4 per cent
	3.	Acid insoluble ash	Not more than 2·0 per cent

Preparations—The following are the more important preparations made from the plant :—

A. *Belladonna herba*

Preparations of the belladonna herb

(i) Belladonna Præparata (Prepared belladonna herb). Prepared belladonna herb is belladonna herb, reduced to a fine powder and adjusted, if necessary, either by the admixture in suitable proportions of powdered belladonna herb, having lower or higher alkaloidal content, or by the addition of powdered exhausted belladonna herb, to contain 0·3 per cent of alkaloids, calculated as hyoscyamine (limit 0·28 to 0·32).

(ii) Extractum Belladonna Siccum (Dry extract of belladonna).

Dry extract of belladonna contains 1·0 per cent of the alkaloids of belladonna herb, calculated as hyoscyamine (limits 0·95 to 1·05).

(iii) Tinctura Belladonna (Tincture of belladonna). Tincture of belladonna is prepared by percolation with alcohol (70 per cent) and contains 0·03 per cent w/v of the alkaloids of bellodanna herb, calculated as hyoscyamine (limits 0·028 to 0·032).

B. *Belladonna radix*

Preparations of the belladonna root

(i) Extractum Belladonnæ Liquidum (Liquid extract of belladonna).

Liquid extract of belladonna contains 0·75 per cent w/v of alkaloids of belladonna root, calculated as hyoscyamine (limits 0·70 to 0·80).

(ii) Linimentum Belladonnæ (Liniment of belladonna).

Liniment of belladonna contains 0·375 per cent w/v of the alkaloids of belladonna root, calculated as hyoscyamine (limits 0·350 to 0·400), together with camphor.

(iii) Suppositoria Belladonnæ. Each suppository contains 0·15 ml. (2½ minims) of liquid extract of belladonna ; unless otherwise stated.

Besides these there are several other preparations, of tinctures, extracts, ointments, etc., which are official in the B.P.C.

In India the Drug Research Laboratory, Jammu Tawi, is the most important unit for the manufacture of belladonna preparations from indigenous resources, where the whole of belladonna produced in Jammu and Kashmir State is processed into extract of belladonna leaf, extract of belladonna root, belladonna plaster, liniment of belladonna, tincture belladonna, etc.

Adultrants—The leaves of *Phytolacca acinosa* Roxb. (known locally in Kashmir as ***lubar***) closely resemble those of belladonna and are often substituted for it. In field, where both species occur in close association, belladonna can be easily distinguished from the other by the following characters :—

	Atropa acuminata plant	*Phytolacca acinosa* plant
1.	Leaf acuminate	Leaf ovate.
2.	Midrib not stout.	Midrib stout.
3.	Leaf slightly long stalked.	Leaf short stalked.
4.	Flowers singly or in groups of 2–4	Flowers indefinite and in long receme.
5.	Flowers bigger than phytolacca flowers and are greenish-yellow in colour.	Flowers small and white.

Atropa acuminata root	*Phytolacca acinosa* root
1. Not so light as phytolacca root.	1. Light.
2. Breaking quickly and the exposed surface starchy.	2. Breaking irregularly across into pieces with larger and smaller projecting edges and splinters, and the exposed surface is devoid of starch.

The roots of *Althea officinalis* Linn. are also sometimes said to be adulterated with the genuine drug.

CULTIVATION

In India the drug has been collected mostly from wild plants although small scale cultivation has been attempted from time to time. Recently, however, its cultivation is being tried on a large scale in Kashmir State, and experimental cultivation has also been started in Chakrata (U.P.). Actually very little information is available about the conditions governing the successful cultivation of this plant, but, since it closely resembles the foreign species *Atropa belladonna,* most of the data available on the cultivation of the latter could be useful in raising Indian belladonna by adopting suitable cultural practices, consistent with the Indian conditions of soil and climate. The details regarding cultivation of *A. belladonna* are described hereunder.

Climate—The plant thrives in the temperate regions with less rainfall. It is, therefore, suggested that its cultivation could be attempted in the W. Himalayas at altitudes of 6,000 to 10,000 feet preferably in the inner ranges. Plants grown in sunny situations are said to be richer in alkaloidal content and more luxuriant in growth than those grown in the shade.

Soil—Belladonna requires loamy soils rich in lime with adequate subsoil drainage supplemented by abundant balanced nitrogenous manuring, organic or inorganic. In general well-drained loams suitable for growing vegetables are good for belladonna cultivation. If the subsoil were poor or if there were water-logging a large number of plants die.

Nursery work—The plant could be propagated from seedlings or, in a small way, from cuttings from young shoots which are rooted in moist sand or from cuttings of thick rootstocks made early in the spring. However, large-scale cultivation should always be done by raising seedlings in a nursery. Direct sowing of seeds in the field seldom gives good results. Belladonna seeds are small and an ounce of these contains approximately 30,000 seeds. About an ounce or two of seed depending upon their viability will provide enough plants (about 10,000) for an acre. Seed mixed with sufficient quantity of sand is sown thickly in pots or well-drained boxes in late winter in greenhouse, or in outdoor seed-beds early in spring. These pots or beds are covered very lightly with sieved soil and well-rotted farmyard manure pressed down so that the seeds may come in close contact with the soil. The top soil is kept moist immediately after sowing by irrigation through a sprayer. Belladonna seeds germinate very slowly and unevenly. It usually takes 4 to 6 weeks to obtain a good stand of seedlings. Various treatments commonly employed for reducing the thickness of the seed coat to induce early germination may be applied. In the case of Indian belladonna (*Atropa acuminata*) it is reported by Kapoor *et al.* (1952), that seeds sown in March in Srinagar ordinarily took 4 to 5 weeks to germinate. The days temperature during those days varied between 50° to 70°F. although the night temperature was much lower. They further reported that the period of germination was shortened if the seeds were pretreated with 80 per cent sulphuric acid for a short time up to 2 minutes, but this treatment, if adopted, requires to be done carefully. When the seedlings grown indoors grow to a sufficient height that can be handled, they are transplanted to light rich soil in small individual pots or in flat shallow boxes where the transplants are arranged at a distance of 2 inches from each other. As soon as danger of frost

is over they are planted out to a deeply ploughed and well-prepared field, and set in rows 30 inches apart from each other with a spacing of 20 inches between the plants in the rows. With this spacing of planting about 10,000 plants will be required for one acre.

The seeds may also be sown in well-pulverized beds in March or April directly in the field, in drills about 30 inches apart from one another. For this purpose about 1 lb. of seeds per acre will be required. When the seedlings are large enough they are thinned out to stand about 20 inches apart from each other. As the seeds germinate slowly, and as they are then easily damaged by insect pests or scorching by the sun, it is often better to raise the seedlings in the greenhouse. In this case seedlings are ready for setting in the field earlier and a much larger crop is generally obtained.

According to Brewer *et al.* (1950), the yield of leaves per plant from *A. belladonna* is higher at a spacing of 18 inches by 18 inches than in either a closer (12 inches by 12 inches) or a wider (24 inches by 24 inches) spacing. The total yield of leaves per acre, is however, higher in a 12 inches spacing than in 18 inches or a wider spacing, owing to the greater number plants per acre. At different spacing he obtained the following yields :—

Belladonna production at different field spacing

Annual production in pounds of air-dried weight $\frac{\text{(lb./plant)}}{\text{(lb./acre)}}$

Spacing of 12″ × 12″	Spacing of 18″ × 18″	Spacing of 24″ × 24″
$\frac{0\cdot164}{6086}$	$\frac{0\cdot173}{4830}$	$\frac{0\cdot158}{2942}$

The yield of the alkaloids from the plants grown at the above spacing has not been given by Brewer ; but it would be interesting to investigate the alkaloidal yield also at the above spacing, both from the leaves as well as from the roots.

Preparatory tillage—Soil should be prepared thoroughly as is done for vegetables. A light dressing of farmyard manure, supplemented by basic slag or superphosphate may be given when preparing the land ; the latter should be added in a dose depending on the difficiency of P_2O_5 in the soil. Lay-out of the land may be done in accordance with the gradient of the soil and irrigation facilities available. When the land is fully prepared to receive the seedlings, transplanting in the field may be done in March or April after light shower of rain or after light irrigation in order to secure early establishment of the seedlings.

Weeding and hoeing—Frequent weeding and hoeing is necessary for its successful cultivation.

Top dressing or manuring—Various workers have concluded from elaborate manuria experiments, that a high calcarious soil with abundant balanced nitrogenous manuring during plant growth are essential for production of a good belladonna crop possessing high alkaloidal content. As such after ascertaining the optimum quantity of calcium and P_2O_5 nutrients in the soil, top dressing with adequate quantity of nitrogenous manure is essential for its successful cultivation.

According to Brewer *et al.* (1950), a higher yield of the alkaloids is obtained from the plants when ammonium sulphate is added to them soon after the plants have established in the field than if the fertilizers were added at later stages of growth.

Diseases and their control—In England and America the plant is susceptible to a number of fungal and insect diseases. The root fungus (a species of *Phytopthora*) has caused havoc in European plantations and there is no practical means of controlling this disease. The plant is also liable to the attack of insects such as flea beetle, the common potato beetle, the cut-worm and the stalk-borer. Derris or D.D.T. insecticide dusts or sprays are used on plants of all ages as a protection. It is gratifying to note that no such disease is reported in India. Only very recently a case of the attack of some fungus or insect is reported from Himachal Pradesh State.

Collection of cultivated crop—If growth has been satisfactory a small crop of leaves may be plucked in the autumn of the 1st season, but the first main crop is collected about the end of June (at the time of flowering) in the year following that in which the seed was sown. Usually a second crop of leaves can be collected in August, and sometimes a third, late in September. In bad seasons only two crops are available. The plant being perennial, it can be harvested in the same manner for the second and third summer. Belladonna plants are at their best up to the third or the fourth year. At the end of the third or fourth summer the roots are dug up, cleaned by washing, cut into short pieces about 4 inches long, the thicker ones being sliced lengthwise, and dried in the sun.

Collection of wild plants—Leaves and flowering tops are usually collected when the plant is in flower, i.e., July–September. However, Chopra *et al.* (1946) found that the best time of collection is when the plant starts flowering at the beginning of August, when it is richest in alkaloids. Thereafter the alkaloidal content decreases and is at its minimum when it sets fruits, i.e., in November.

The collection of wild roots is somewhat difficult, as the plants are scattered. Further, since the drug shows much variation in size, it is difficult to judge the age of the plant. As such the alkaloidal content of roots varies to a great extent. Sometimes these roots are pulled out by means of small stem-portions on the tops, therefore, full length of the root does not appear to be collected, since some of the roots get broken in the soil. Besides, the drug collected in this way contains a high proportion of stem which lower its alkaloidal content. According to the 5th Addendum to the British Pharmacopœa of 1932 the drug is required to contain not more than 25 per cent of rootstock and aerial stem bases*. Therefore, special care must be taken in the collection of roots. Besides, shrunken and spongy roots are usually rejected as they are low in alkaloidal content.

Seed collection—While harvesting the plants for leaf collection the best plants are kept for seed. The seed ripens from September–November. The ripe berries are collected and the pulp separated from the seeds. The latter are then dried in the sun and stored in bags.

Yield—In the U.S.A., the average yield per acre of dried herb is 600 lbs., in a season, but a yield of considerably more than 1,000 lbs. per acre has also been obtained. The yield of roots is 150 to 300 lbs. per acre (Sievers, 1948).

In England, the average yield per acre of "dry herb" (Bull. No. 121 of 1948 by Ministry of Agriculture and Fisheries, London) is said to be 2,240 lbs.

Drying—The collected herb must be carefully handled and dried rapidly in the shade in order to get the maximum alkaloidal content of hyoscyamine in the crude drug, and also

* In British Pharmacopœa, 1948, no such limit now exists, but U.S. Pharmacopœa, 1942, 12th revision gives the following standard :—

"Belladonna root contains not more than 10 per cent of its stem-bases and woody crowns".

to retain its colour. Small quantities of such material sometimes dry satisfactorily if spread thinly on clean wooden floors and turned over frequently, or if hung up by strings in small bunches in covered places which resemble tobacco drying places, but weather conditions will largely determine the success of these practices.

Youngken *et al.* (1948) report that the drying under infrared lamps at a very high temperature destroys the alkaloidal content.

In some foreign countries the use of gentle heat from a stove or fireplace in a building designed for this or similar purposes is made for handling large quantities rapidly.

Storage—If storage is necessary the material should be stored in a clean, dry place protected from light.

Packing—As a rule it is best to send the finished product to the market as soon as possible, so as to avoid lengthy storage during which damage by moisture, insects or rodents might occur.

In India dried leaves and dried roots are marketed in clean gunny bags. But in England and America the leafy drugs are usually not acceptable unless in reasonably whole condition. Therefore, such products are packed firmly in cardboard cortons lined with paper and sealed to prevent spillage of the finer particles.

Markets and prices—In Kashmir State, the collection and marketing of belladonna is done under Government control. The drug collected from wild and cultivated plants is sent to the Divisional Forest Officer, Utilization Division, Baramulla (Kashmir) from where it is disposed of. The annual output from Kashmir State is about 260 maunds of root and about 290 maunds of leaves (Average for 1944–45 to 1948–49). Since 1945, Drug Research Laboratory, Jammu Tawi, takes up all the raw material produced in the Jammu and Kashmir State and nothing is sold outside.

The drug is also collected from Kulu and Chamba, but this collection is quite small.

The price of the drug is fixed by the Kashmir Government and it varies from year to year depending on collection and demand of the market. During the year 1947–48 the prices were Rs. 182 per maund of root and Rs. 202 per maund of leaves.

Addresses of some suppliers of Indian Belladonna :—

1. Divisional Forest Officer, Utilization Division, P.O. Baramulla (Jammu and Kashmir State).
2. Divisional Forest Officer, Kulu Forest Division, Kulu (Punjab).
3. Shri Kuljas Ram, Forest Contractor, Akhara Bazar, Kulu (Punjab).

Addresses of some dealers of Belladonna preparations :—

1. Drug Research Laboratory, Jammu Tawi (Jammu and Kashmir State).
2. M/s. Bengal Chemical & Pharmaceutical Works, Calcutta.
3. Smith Stanistreet & Co., Ltd., P.O. Box. 172, Calcutta.
4. Zandu Pharmaceutical Works Ltd., Gokhale Road, Bombay 14.
5. B. K. Paul & Co., Ltd., 1 and 3, Bonfield Lane, Calcutta.

Addresses of some exporters :—

1. Smith, Stanistreet & Co., Ltd., P.O. Box. 172, Calcutta.
2. B. K. Paul & Co., Ltd., 1 and 3 Bonfield Lane, Calcutta.
3. Adam Oosman, Oosman Building, 8, Balai Dutt Street, Calcutta.

ACKNOWLEDGEMENT

I am grateful to Mr. R. L. Badhwar, Officer-in-Charge, Minor Forest Products Branch, Forest Research Institute, for his generous help and guidance in this work.

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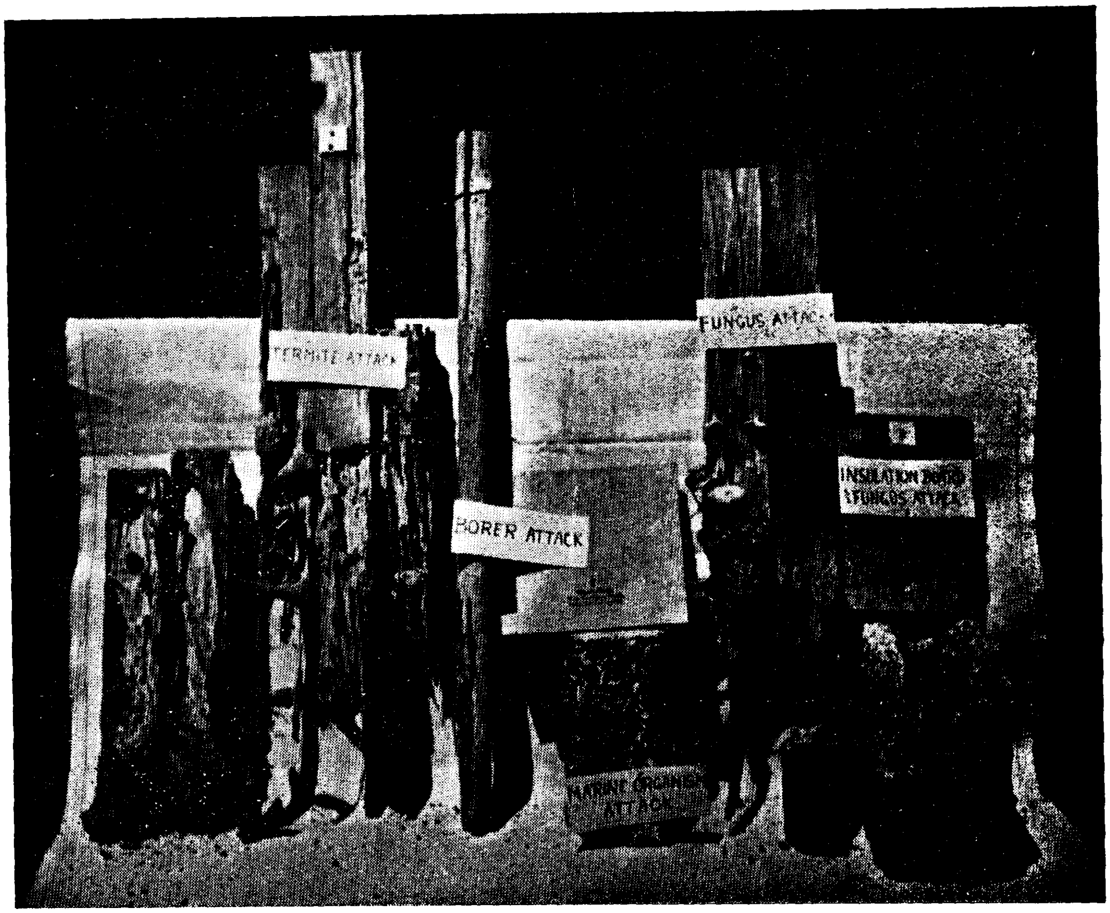
PLATE No. 2

Deterioration of timber due to attack by termites, borers, marine organisms, fungi and fire.

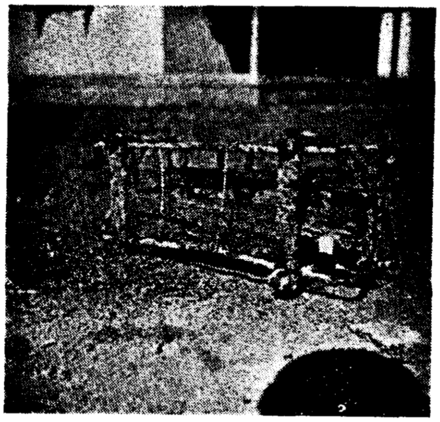
2/1



The small dot like marks on the two extreme left specimens are the termites on an attacked specimen thereon, moving into crevices of the specimens to hide themselves from light. The above specimens were taken out of the 'Test-Yard' at New Forest and harbours.

PLATE No. 2

2/2



Copper naphthenate treated specimens undergoing tests in Bombay harbour after two years' exposure to marine organisms.

2/3

The two specimens belong to the same pile. The left specimen No. 1 is the but-end driven into the earth and the right specimen No. 2 is the portion above the ground level. This is badly attacked by marine organism and barnacles on it can be seen. This pile is taken out of Cochin harbour after 2 years.

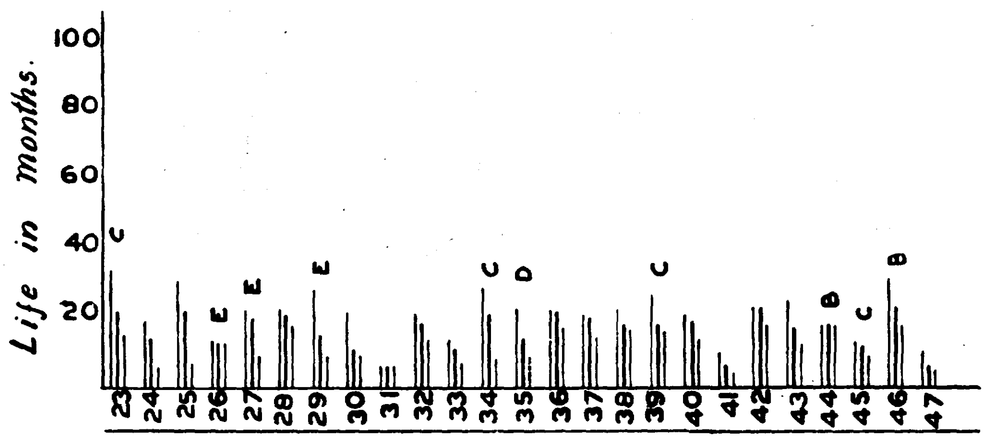
2/4

Shows the damage to a teak log nearly 4′ in diameter by fire in the Bhadravati depot.

FIG. 2/6—(*concld.*)

Results of Natural Durability Tests at F.R.I. 'Graveyard'.

CLASS VI
NATURAL DURABILITY GRAVEYARD TEST
AVERAGE LIFE 0 TO 23 MONTHS.



Legend of the letters at the end of the stick diagrams :—

A—Heart wood easily treatable.

B—Heart wood treatable but complete penetration not always obtained.

C—Heart wood only partially treatable.

D—Heart wood refractory to treatment ; incision necessary for ¼" to ¾" penetration.

E—Heart wood very refractory to treatment ; side and end penetration practically nil.

23.	*Hymenodictyon excelum*	.. (kuthan)	.. U.P.
24.	*Juglans fallax*	.. (walnut)	.. Kashmir.
25.	*Juglans regia*	.. (walnut)	.. Punjab.
26.	*Lannea grandis*	.. (jhingan)	.. U.P.
27.	*Machilus gamblei*	.. (machilus)	.. Burea Range Hamiltonganj.
28.	*Mallotus philippinensis*	.. (champ)	.. Dehra Dun.
29.	*Michelia excelsa*	.. (champ)	..
30.	*Miliusa velutina*	..	.. Dehra Dun, U.P.
31.	*Myristica attenuata*	.. (myristica)	.. Madras.
32.	*Parishia insignis*	.. (red dhup)	.. Andamans.
33.	*Parrotia jacquemontiana*	.. (parrotia)	.. Punjab.
34.	*Phœbe* spp.	.. (bonsum)	..
35.	*Picea morinda*	.. (spruce)	.. Kashmir.
36.	*Planchonia andamanica*	.. (red bombway)	.. Assam.
37.	*Polyalthia fragrans*	..	.. Madras.
38.	*Pongamia glabra*	..	.. Bombay.
39.	*Pterospermum acerifolium*	.. (mayand)	..
40.	*Sonneratia apetala*	.. (keora)	.. Bengal.
41.	*Sterculia campanulata*	.. (papita)	..
42.	*Stereospermum chelonoides*	..	.. Assam.
43.	*Stereospermum suaveolens*	.. (padri wood)	.. Dehra Dun.
44.	*Swintonia floribunda*	.. (taungthayet)	.. Burma.
45.	*Terminalia chebula*	.. (myrobolan wood)	.. Assam.
46.	*Terminalia pyrifolia*	.. (lein)	.. Burma.
47.	*Ulmus wallichiana*	.. (elm)	.. Punjab.

FIG. 3

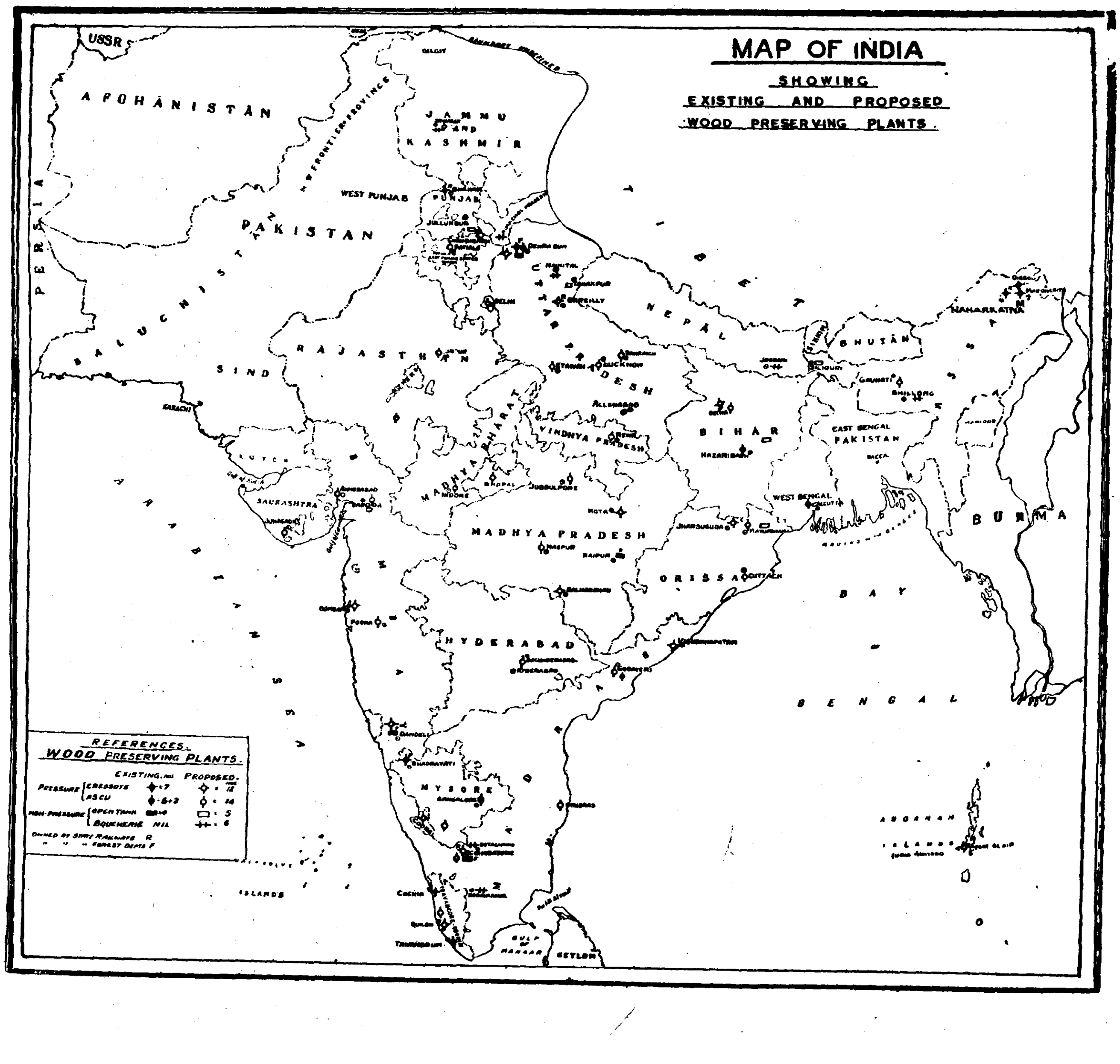
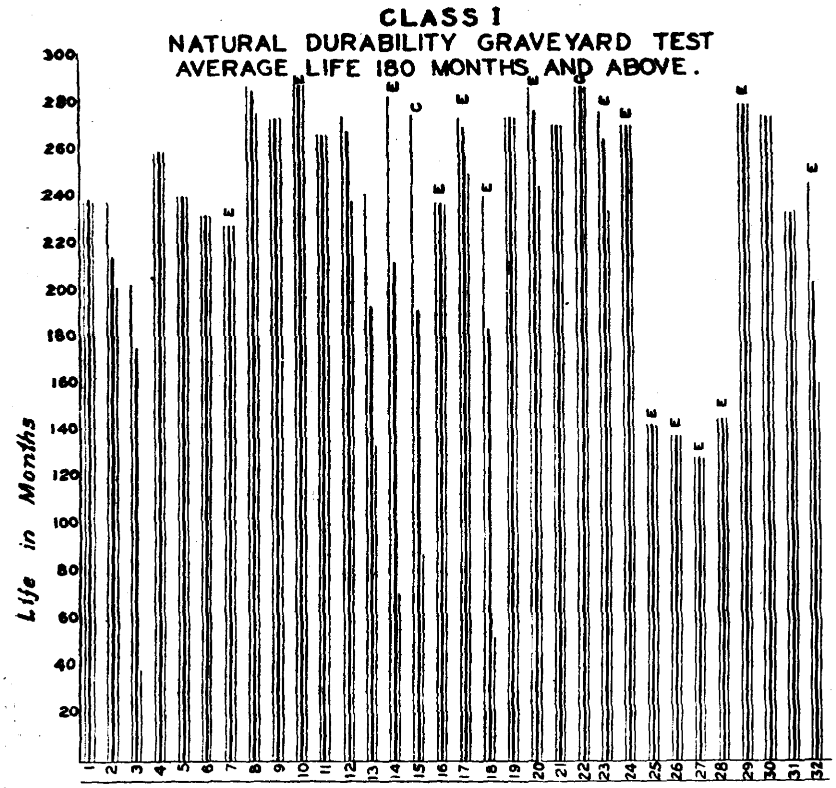

MAP OF INDIA
SHOWING
EXISTING AND PROPOSED
WOOD PRESERVING PLANTS.
USSR
AFGHANISTAN
PERSIA
BALUCHISTAN
PAKISTAN
WEST PUNJAB
SIND
KARACHI
JAMMU AND KASHMIR
PUNJAB
TIBET
NEPAL
BHUTAN
RAJASTHAN
UTTAR PRADESH
BIHAR
EAST BENGAL PAKISTAN
WEST BENGAL
KUTCH
SAURASHTRA
MADHYA BHARAT
VINDHYA PRADESH
MADHYA PRADESH
ORISSA
HYDERABAD
MYSORE
BURMA
ARABIAN SEA
BAY OF BENGAL
ANDAMAN ISLANDS
GULF OF MANAAR
CEYLON
REFERENCES.
WOOD PRESERVING PLANTS.
EXISTING. NOS
PROPOSED.
PRESSURE
CREOSOTE =7 = 12
ASCU 6+2 = 24
NON-PRESSURE
OPEN TANK = 5
BOUCHERIE NIL = 6
OWNED BY STATE RAILWAYS R
FOREST DEPTS F

FIG. 2/1

Results of Natural Durability Tests at F.R.I. 'Graveyard'.



Legend of the letters at the end of the stick diagrams :—

A—Heart wood easily treatable.
B—Heart wood treatable but complete penetration not always obtained.
C—Heart wood only partially treatable.
D—Heart wood refractory to treatment ; incision necessary for ½" to ¾" penetration.
E—Heart wood very refractory to treatment ; side and end penetration practically nil.

1.	*Acacia catechu**	.. (cutch)	.. Dehra Dun.
2.	*Artocarpus lakoocha**	.. (lakooch)	.. Bihar and Orissa.
3.	*Bassia butyracea**	..	.. South Andamans.
4.	*Berrya ammonilla**	.. (Trincomalee wood)	Burma.
5.	*Carapa moluccensis**	.. (pusur)	.. Burma.
6.	*Cinnamomum inunctum**	..	.. Burma.
7.	*Cupressus torulosa**	.. (cypress)	.. Garhwal, U.P.
8.	*Dalbergia latifolia**	.. (Indian rose wood)	.. M.P.
9.	*Dalbergia oliveri**	.. (tamalan)	.. Burma.
10.	*Dalbergia sissoo**	.. (sissoo)	.. U.P.
11.	*Dysoxylum malabaricum**	.. (white cedar)	..
12.	*Gluta tavoyana**	.. (gluta)	.. Burma.
13.	*Gmelina arborea**	.. (gamari)	.. U.P.
14.	*Hardwickia binata**	.. (anjan)	.. Madras.
15.	*Heterophragma adenophyllum**	..	.. Burma.
16.	*Hopea cordifolia**	.. (hopea)	.. Madras.
17.	*Hopea parviflora**	.. (hopea)	.. Madras.
18.	*Lagerstrœmia lanceolata**	.. (benteak)	.. Madras.
19.	*Melanorrhœa usitata**	.. (thitsi)	..
20.	*Mesua ferrea**	.. (mesua)	.. Assam.
21.	*Pentacme suavis**	.. (ingyin)	.. Burma.
22.	*Pterocarpus dalbergioides**	.. (Andaman padauk)	..
23.	*Pterocarpus marsupium**	.. (bijasal)	.. Bombay.
24.	*Shorea robusta**	.. (sal)	.. Burma.
25.	*Shorea robusta**	.. (sal)	.. Bengal.
26.	*Shorea robusta**	.. (sal)	.. Ramnagar, U.P.
27.	*Shorea robusta**	.. (sal)	.. Gorakhpur, U.P.
28.	*Shorea robusta**	.. (sal)	.. Haldwani, U.P.
29.	*Shorea robusta**	.. (sal)	.. U.P.
30.	*Soymida febrifuga**	..	M.P.
31.	*Vitex altissima**	.. (milla)	.. Kanara.
32.	*Xylia xylocarpa**	.. (irul)	..

* Indicates that some of the specimens are not yet rejected and are undergoing tests in the yard. Their average life given here is calculated up-to-date only.

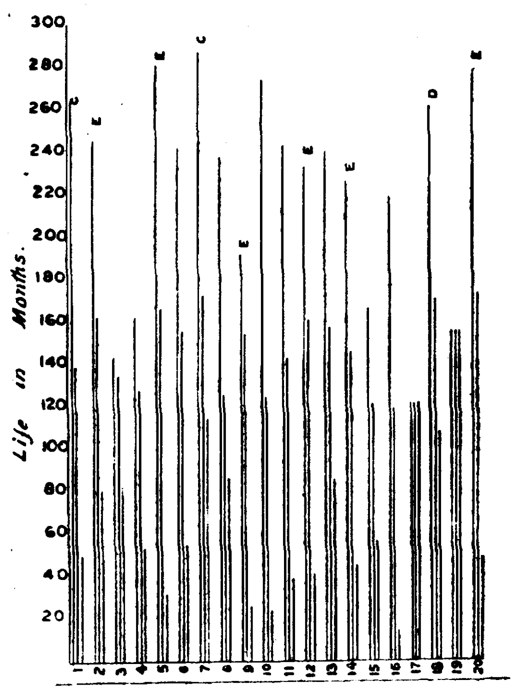
FIG. 2/2

Results of Natural Durability Tests at F.R.I. 'Graveyard'.

CLASS II

NATURAL DURABILTY GRAVEYARD TEST

AVERAGE LIFE 120 TO 179 MONTHS.



Legend of the letters at the end of the stick diagrams :—

A—Heart wood easily treatable.

B—Heart wood treatable but complete penetration not always obtained.

C—Heart wood only partially treatable.

D—Heart wood refractory to treatment ; incision necessary for $\frac{1}{2}''$ to $\frac{3}{4}''$ penetration.

E—Heart wood very refractory to treatment ; side and end penetration practically nil.

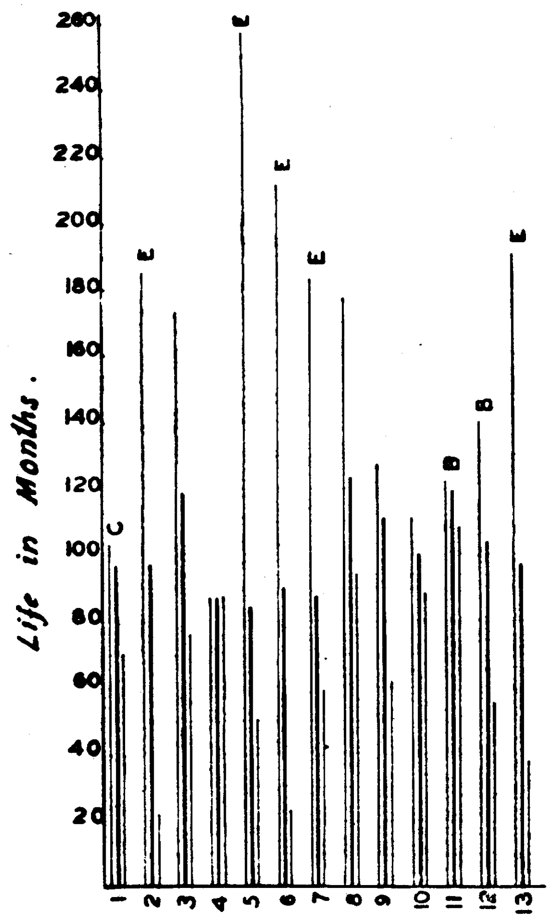
1.	*Albizzia lebbek*	.. (kokko)	..
2.	*Albizzia odoratissima**	.. (black siris)	..
3.	*Amoora rohituka*	.. (amoora)	.. Assam.
4.	*Artocarpus integrifolia*	.. (jack)	.. Malabar.
5.	*Bassia latifolia**	.. (mahua)	.. Bihar and Orissa.
6.	*Careya arborea**	..	.. U.P.
7.	*Cedrus deodara**	.. (deodar)	.. Punjab.
8.	*Eriolæna candollei*	.. (solomon wood)	.. U.P.
9.	*Eucalyptus* spp.*	..	.. Nilgiris Hills.
10.	*Gluta travancorica**	..	.. Madras.
11.	*Hopea glabra**	..	.. Madras.
12.	*Lagerstrœmia lanceolata*	.. (benteak)	..
13.	*Machilus macrantha**	.. (machilus)	.. Madras.
14.	*Mesua ferrea*	.. (Mesua)	.. Madras.
15.	*Michelia montana*	.. (champ)	.. Assam.
16.	*Mimusops elengi**	.. (bullet wood)	.. Madras.
17.	*Ougenia dalbergioides*	.. (sandan)	.. Northern circle, M.P.
18.	*Pentace burmanica*	.. (thitka)	.. Burma.
19.	*Pentace griffithii**	..	.. Burma.
20.	*Tectona grandis**	.. (teak)	.. M.P.

* Indicates that some of the specimens are not yet rejected and are undergoing tests in the yard. Their average life given here is calculated up-to-date only.

FIG. 2/3

Results of Natural Durability Tests at F.R.I. 'Graveyard'.

CLASS III
NATURAL DURABILITY GRAVEYARD TEST
AVERAGE LIFE 84 TO 119 MONTHS.



Legend of the letters at the end of the stick diagrams:—

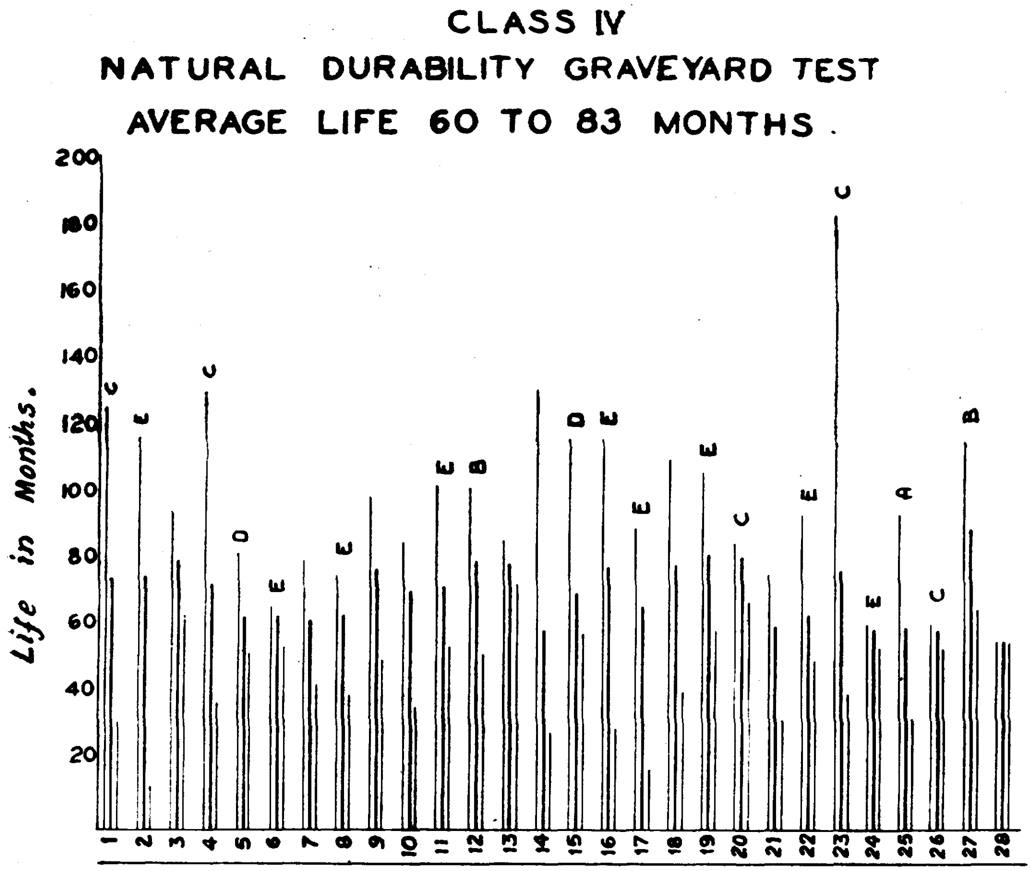
A—Heart wood easily treatable.
B—Heart wood treatable but complete penetration not always obtained.
C—Heart wood only partially treatable.
D—Heart wood refractory to treatment; incision necessary for ½" to ¾" penetration.
E—Heart wood very refractory to treatment; side and end penetration practically nil.

1.	*Albizzia procera*	.. (white siris)	.. Bihar and Orissa.
2.	*Bursera serrata*	.. (Indian red pear)	.. Bihar and Orissa.
3.	*Cassia fistula**	.. (rajbrikh)	.. Assam.
4.	*Castanopsis tribuloides*	..	.. Burma.
5.	*Dichopsis elliptica*	.. (pali)	.. Madras.
6.	*Eugenia jambolana*	.. (jaman)	.. Bihar and Orissa.
7.	*Lagerstrœmia flos-reginæ*	.. (jarul)	..
8.	*Lagerstrœmia hypoleuca*	.. (jarul)	..
9.	*Lagerstrœmia microcarpa*	..	..
10.	*Stereospermum xylocarpum*	..	.. Madras.
11.	*Terminalia arjuna*	.. (arjun)	.. South Chanda, M.P.
12.	*Terminalia tomentosa**	.. (laurel)	.. Burma.
13.	*Xylia dolabriformis*	.. (pyinkado)	.. Burma.

* Indicates that some of the specimens are not yet rejected and are undergoing tests in the yard. Their average life given here is calculated up-to-date only.

FIG. 2/4

Results of Natural Durability Tests at F.R.I. 'Graveyard'.



Legend of the letters at the end of the stick diagrams :—

A—Heart wood easily treatable.
B—Heart wood treatable but complete penetration not always obtained.
C—Heart wood only partially treatable.
D—Heart wood refractory to treatment; incision necessary for ½" to ¾" penetration.
E—Heart wood very refractory to treatment; side and end penetration practically nil.

1.	*Albizzia procera*	.. (white siris)	.. Assam.
2.	*Altingia excelsa*	.. (jutili)	.. Assam.
3.	*Amoora wallichii*	.. (amoora)	.. Bengal.
4.	*Anogeissus acuminata*	.. (yon)	.. Burma.
5.	*Artocarpus chaplasha*	.. (chaplash)	.. Assam.
6.	*Bursera serrata*	.. (Indian red pear)	.. Burma
7.	*Calophyllum elatum*	.. (poon)	.. Madras.
8.	*Calophyllum tomentosum*	.. (poon)	.. Bombay.
9.	*Cedrela serrata*	.. (hill toon)	.. Burma.
10.	*Cleistanthus collinus*	..	.. Andamans.
11.	*Dalbergia sissoo*	.. (sissoo)	..
12.	*Dipterocarpus indicus*	.. (gurjan)	.. Coorg.
13.	*Dysoxy-lum binectariferum*	..	.. Burma.
14.	*Eugenia kanarensis*	.. (jaman)	.. Burma.
15.	*Grewia tiliæfolia*	.. (dhaman)	.. Madras.
16.	*Hopea odorata*	.. (Andaman thingan)	.. Burma.
17.	*Kayea assamica*	.. (sianahor)	.. Assam.
18.	*Lagerstrœmia microcarpa*	.. (benteak)	..
19.	*Parashorea stellata*	.. (thingadu)	.. Burma.
20.	*Phœbe hainesiana*	.. (bonsum)	.. Assam.
21.	*Podocarpus nerrifolia*	.. (thitmin)	.. Andaman.
22.	*Pœciloneuron indicum*	.. (ballagi)	.. Madras.
23.	*Quercus lineata*	.. (phalat)	.. Darjeeling.
24.	*Shorea talura*	.. (talura)	..
25.	*Terminalia manii*	.. (black chuglam)	.. M.P.
26.	*Terminalia paniculata*	.. (kindal)	..
27.	*Terminalia tomentosa*	.. (laurel)	.. M.P.
28.	*Zanthoxylum rhetsa**	.. (mullilam)	.. Madras.

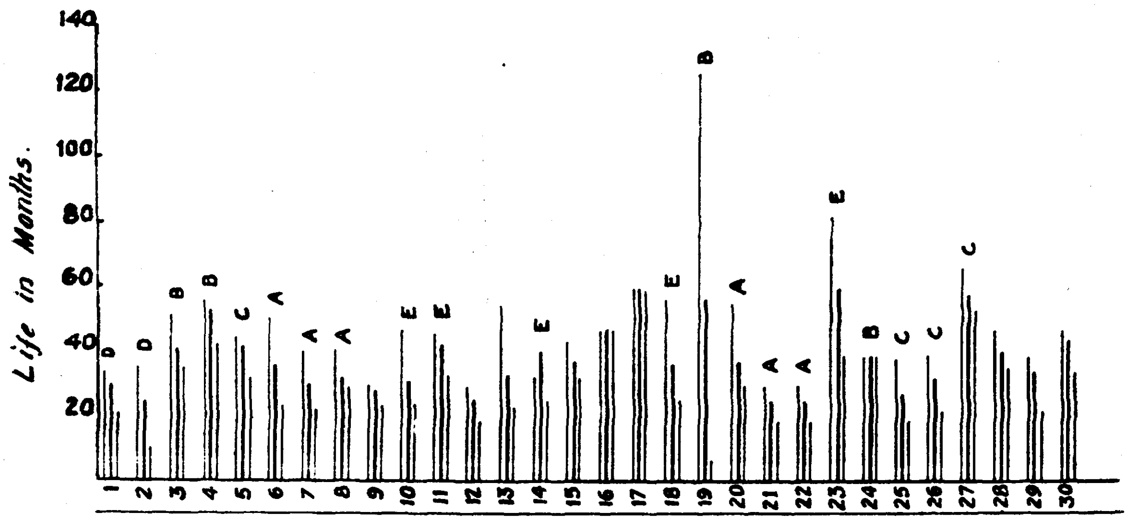
* Indicates that some of the specimens are not yet rejected and are undergoing tests in the yard. Their average life given is calculated up-to-date only.

FIG. 2/5

Results of Natural Durability Tests at F.R.I. 'Graveyard'.

CLASS V.

NATURAL DURABILITY GRAVEYARD TEST
AVERAGE LIFE 24 TO 59 MONTHS.



1.	*Abies pindrow*	.. (fir)	.. U.P.
2.	*Abies pindrow*	.. (fir)	.. N.W.F.P.
3.	*Acacia arabica*	.. (babul)	.. Sind.
4.	*Acacia arabica*	.. (babul)	.. Sind.
5.	*Acrocarpus fraxinifolius*	.. (mundani)	.. Pollachi Malabar.
6.	*Adina cordifolia*	.. (haldu)	..
7.	*Adina cordifolia*	.. (haldu)	.. Bihar and Orissa.
8.	*Adina cordifolia*	.. (haldu)	.. U.P.
9.	*Aegle marmelos*	.. (bel)	.. Gonda U.P.
10.	*Albizzia lucida*	.. (tepria siris)	.. Assam.
11.	*Albizzia stipulata*	.. (kala siris)	.. Bihar and Orissa.
12.	*Alstonia scholaris*	.. (shaitan wood)	..
13.	*Anisoptera glabra*	.. (kaunghmu)	.. Burma.
14.	*Anogeissus latofolia*	.. (axle wood)	.. Punjab.
15.	*Anogeissus pendula*	.. (kardahi)	.. Jhansi U.P.
16.	*Artocarpus hirsuta*	.. (aini)	.. Bombay.
17.	*Artocarpus integrifolia*	.. (jackwood)	..
18.	*Bischofia javanica*	.. (bishopwood)	.. Assam.
19.	*Borassus flabellifer*	.. (palmyra palm)	.. Bihar.
20.	*Bruguiera* spp.	..	..
21.	*Bruguiera* spp.	..	..
22.	*Bruguiera* spp.	..	..
23.	*Calophyllum wightianum*	.. (poon)	.. Bombay.
24.	*Castanopsis hystrix*	.. (Indian chestnut)	.. Assam.
25.	*Casuariana equisetifolia*	.. (casuarina)	..
26.	*Cedrela toona*	.. (toon)	.. Burma.
27.	*Chukrasis tabularis*	.. (chickrassy)	.. Assam.
28.	*Chloroxylon swietenia*	.. (East Indian satinwood)	.. M. P.
29.	*Cinnamomum cecidodaphne*	.. (cinnamon)	.. Dehra Dun U.P.
30.	*Cinnamomum iners*	.. (cinnamon)	.. Burma.

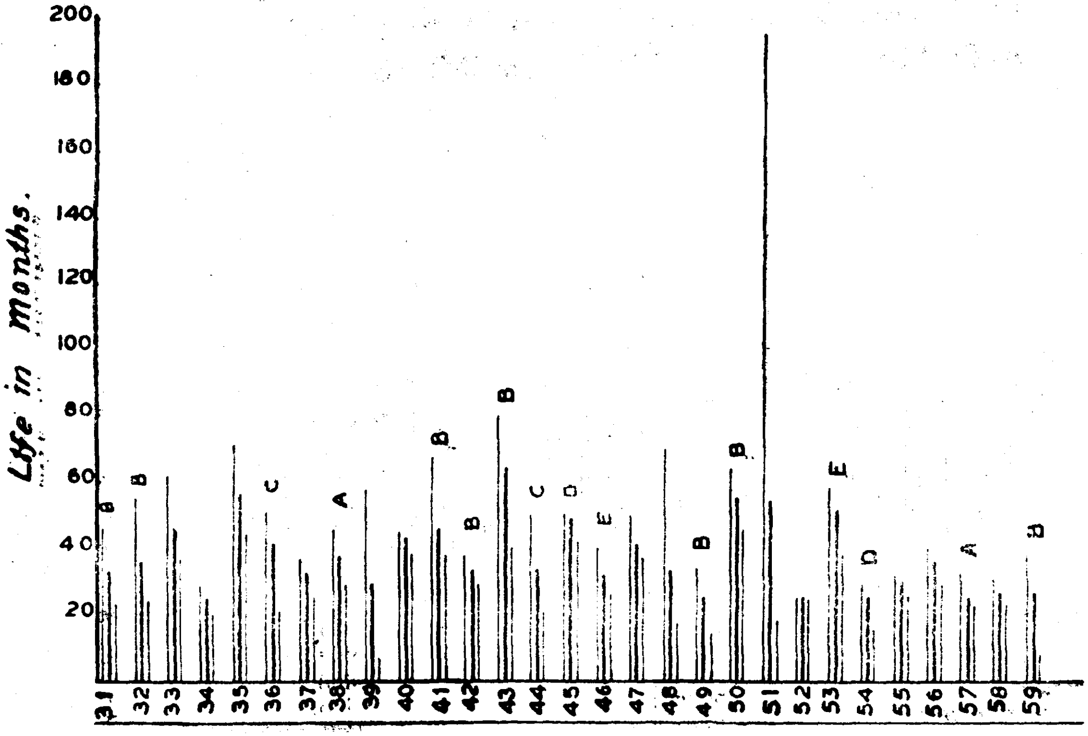
Legend of the letters at the end of the stick diagrams :—

A—Heart wood easily treatable. B—Heart wood treatable but complete penetration not always obtained.
C—Heart wood only partially treatable. D—Heart wood refractory to treatment ; incision necessary for ¼" to ½" penetration.
E—Heart wood very refractory to treatment ; side and end penetration practically nil.

(Contd.)

FIG. 2/5—(*Contd.*)
Results of Natural Durability Tests at F.R.I. 'Graveyard'.

CLASS V
NATURAL DURABILITY GRAVEYARD TEST
AVERAGE LIFE 24 TO 59 MONTHS.



31.	*Crypteronia paniculata*	..	.. Assam.
32.	*Cynometra polyandra*	.. (ping)	.. Assam.
33.	*Dalbergia paniculata*	..	.. U.P.
34.	*Dillenia indica*	.. (dillenia)	.. Assam.
35.	*Dipterocarpus alatus*	..	.. Burma.
36.	*Dipterocarpus griffithii*	.. (gurjan)	.. Andamans.
37.	*Dipterocarpus kerrii*	.. (gurjan)	..
38.	*Dipterocarpus macrocarpus*	.. (hollong)	.. Assam.
39.	*Diospyros melanoxylon*	.. (ebony)	.. M.P.
40.	*Dipterocarpus obtusifolius*	.. (gurjan)	.. Burma.
41.	*Dipterocarpus tuberculatus*	.. (eng)	.. Burma.
42.	*Dipterocarpus turbinatus*	.. (gurjan)	.. Burma.
43.	*Dipterocarpus zeylanicus*	.. (hora)	.. Ceylon.
44.	*Duabanga sonneratioides*	.. (lampati)	.. Bengal.
45.	*Eugenia gardneri*	.. (jaman)	.. Mangalore, S. Kanara
46.	*Eugenia præcox*	.. (jaman)	.. Assam.
47.	*Heritiera minor*	.. (sundri)	.. Pollachii.
48.	*Heterophragma roxburghii*	..	.. M.P.
49.	*Holoptelea integrifolia*	.. (kanju)	.. U.P.
50.	*Homalium tomentosum*	.. (myaukchaw)	.. Burma.
51.	*Isonandra* spp*	..	.. Assam.
52.	*Kayea floribunda*	.. (kayea)	.. Assam.
53.	*Lagerstroemia parviflora*	.. (lendi)	.. South Chanada.
54.	*Lagerstrœmia tomentosa*	.. (leza)	.. Burma.
55.	*Lophopetalum wightianum*	.. (banati)	.. Madras.
56.	*Machilus* spp.	.. (machilus)	.. Bengal.
57.	*Mangifera indica*	.. (mango)	.. Bihar and Orissa.
58.	*Michelia cathcartii*	..	.. Bengal.
59.	*Mitragyna diversifolia*	.. (binga)	.. Burma.

Legend of the letters at the end of the stick diagrams:—

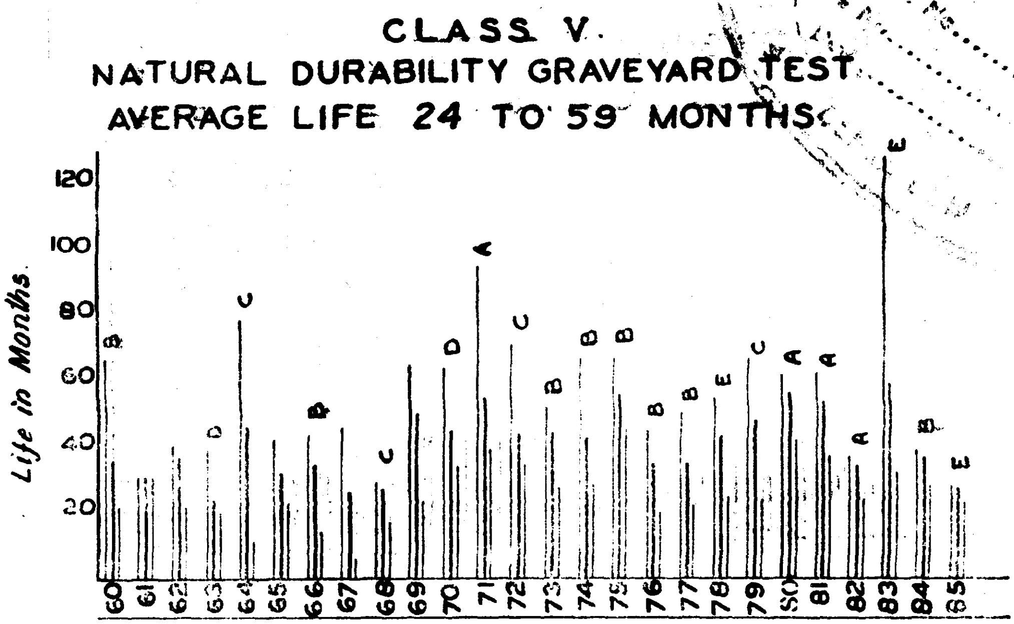
A—Heart wood easily treatable.
B—Heart wood treatable but complete penetration not always obtained.
C—Heart wood only partially treatable.
D—Heart wood refractory to treatment; incision necessary for ½" to ¾" penetration.
E—Heart wood very refractory to treatment; side and end penetration practically nil.

* Indicates that some of the specimens are not yet rejected and are undergoing tests in the yard. Their average life given is calculated up-to-date only.

(*Contd.*)

FIG. 2/5 (*Concld.*)

Results of Natural Durability Tests at F.R.I. 'Graveyard'.



Legend of the letters at the end of the stick diagrams:—
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C—Heart wood only partially treatable.
D—Heart wood refractory to treatment; incision necessary for ½" to ¾" penetration.
E—Heart wood very refractory to treatment; side and end penetration practically nil.

60.	*Mitragyna parvifolia*	.. (kaim)	.. Bihar and Orissa.
61.	*Morus alba*	.. (mulbery)	.. Punjab.
62.	*Morus serrata*	.. (mulberry)	.. Punjab.
63.	*Picea morinda*	.. (spruce)	.. U.P.
64.	*Pinus excelsa*	.. (kail)	.. Punjab.
65.	*Pinus insignis*	..	.. Madras.
66.	*Pinus longifolia*	.. (chir)	.. U.P.
67.	*Podocarpus wallichiana*	.. (thitmin)	.. Burma.
68.	*Quercus lamellosa*	.. (buk)	.. Darjeeling.
69.	*Saccopetalum tomentosum*	..	.. Bombay
70.	*Schima wallichii*	.. (chila-uni)	.. Bengal.
71.	*Schleichera trijuga*	.. (kusum)	.. Bihar and Orissa.
72.	*Shorea assamica*	.. (makai)	.. Assam.
73.	*Terminalia arjuna* (sapwood)	.. (arjun)	.. Madras.
74.	*Terminalia arjuna* (mixed sap and heartwood)	.. (arjun)	.. Madras.
75.	*Terminalia arjuna*	.. (arjun)	.. Madras.
76.	*Terminalia arjuna*	.. (arjun)	.. Madras.
77.	*Terminalia belerica*	.. (bahera)	.. Bihar and Orissa.
78.	*Terminalia bialata*	.. (white chuglam)	.. Andamans.
79.	*Terminalia chebula*	.. (myrobolan wood)	.. Burma.
80.	*Terminalia manii*	.. (black chuglam)	..
81.	*Terminalia myriocarpa*	.. (black hollock)	.. Assam.
82.	*Terminalia myriocarpa*	.. (white hollock)	.. Assam.
83.	*Terminalia oliveri*	.. (than)	.. Burma.
84.	*Terminalia procera*	.. (white bombway/badam)	.. Andamans.
85.	*Vateria indica*	.. (vellapiney)	.. Madras.

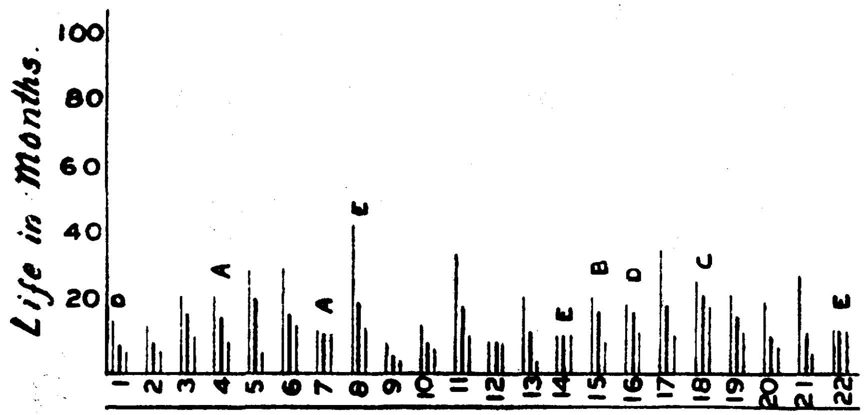
FIG. 2/6

Results of Natural Durability Tests at F.R.I. 'Graveyard'.

CLASS VI

NATURAL DURABILITY GRAVEYARD TEST

AVERAGE LIFE 0 TO 23 MONTHS.



Legend of the letters at the end of the stick diagrams :—

A—Heart wood easily treatable.

B—Heart wood treatable but complete penetration not always obtained.

C—Heart wood only partially treatable.

D—Heart wood refractory to treatment ; incision necessary for ¼" to ½" penetration.

E—Heart wood very refractory to treatment ; side and end penetration practically nil.

1.	***Abies webbiana***	.. (fir)	.. Punjab.
2.	***Acer campbellii***	.. (maple)	.. Darjeeling.
3.	***Ailanthus grandis***	.. (gokul)	.. Bengal.
4.	***Anthocephalus cadamba***	.. (kadam)	.. Assam.
5.	***Bombax insigne***	.. (semul)	.. Andamans.
6.	***Bombax insigne***	.. (semul)	.. Andamans.
7.	***Bombax malabaricum***	.. (semul)	.. Dehra Dun, U.P.
8.	***Boswellia serrata***	.. (salai)	.. Bihar and Orissa.
9.	***Butea frondosa***	.. (dhak)	..
10.	***Canarium euphyllum***	.. (dhup)	.. Andamans.
11.	***Canarium strictus***	.. (dhup)	.. Madras.
12.	***Cratæva religiosa***	..	.. Dehra Dun, U.P.
13.	***Cryptocarya amygdalina***	..	.. Assam.
14.	***Cryptomeria japonica***	.. (suji)	.. Bengal.
15.	***Cullenia excelsa***	.. (karani)	.. Madras.
16.	***Dillenia pentagyna***	.. (dillenia)	.. Bengal.
17.	***Diospyros pyrrhocarpa***	..	.. Andamans.
18.	***Dipterocarpus griffithii***	.. (gurjan)	.. Burma.
19.	***Engelhardtia spicata***	..	.. Assam.
20.	***Fraxinus excelsior***	.. (ash)	.. Chamba State
21.	***Fraxinus floribunda***	.. (ash)	.. Kashmir.
22.	***Garuga pinnata***	..	.. Bihar and Orissa.

(Contd.)

WOOD PRESERVATION IN INDIA

BY DR. A. PURUSHOTHAM, D.SC., F. INST. P., MEM. A.R.E.A., MEM. A.W.P.A.,
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MR. J. N. PANDE, B.SC., *Assistant Wood Preservation Officer and*
MR. Y. G. JADHAVE, B.SC., *Final Year Student,*
Indian Forest College, Dehra Dun

(*Continued from page 634, Vol. 78, No. 12*)

FUTURE SCOPE OF WOOD PRESERVATION IN INDIA

Timber Resources—In India out of a land area of 12,66,892 sq. miles (8,10,679 thousand acres), forests cover only 19 per cent[19a]. Of this area, reports on availability of timber exist only for 2,27,951 sq. miles, classified as "Merchantable area". 1,34,277 sq. miles (59%), and "Unprofitable or inaccessible area" 93,674 sq. miles (41%)[19b]. According to the statistics for the year 1948–49 the present yield of timber from these forests is 93,664 thousand cubic feet or nearly 2 million tons[19c]. This excludes the figures for Madhya Bharat, Rajasthan, Bilaspur and Kutch areas for which correct figures are not available. Of this 2 million tons of timber, 10 per cent or 0·2 million tons comprise coniferous woods (softwoods) like the pine, *deodar*, fir and spruce obtained from Kashmir, Himachal Pradesh, Punjab, Uttar Pradesh, West Bengal and Assam States[20]. The rest are hardwoods. Details of the above figures are given in Table Nos. 5 and 6 (*vide* App.). It is reported that taking into account the yield only of timber from forests, its availability per capita works out from 0·3 to 0·5 cu. ft. This is rather very low and requires to be substantially raised well over 5 cu. ft. per capita. This can be achieved by (1) raising plantations of fast growing species of economic and structural importance so as to reduce the usual rotation of fellings from 75–200 years to 25–50 years, (2) introduction of modern cheap methods for extraction and transportation of timber from areas hitherto considered uneconomical for exploitation, (3) raising of species of timber like *Casuarina*, *babul* and *palmyra* palm, etc., for structural uses ; and *toon*, *sissoo*, mango, etc., for furniture and indoor uses, on non-forest and non-agricultural lands, (4) modern methods of conversion so as to reduce wastage of timber during conversion, (5) use of timber in small dimensions, for all structural purposes adopting modern techniques, (6) elimination of restrictions on the sapwood content in timber for all uses particularly railway sleepers, (7) maximum use of bamboos for diverse purposes and grasses for roofing purposes, and lastly (8) adoption of modern methods of seasoning and preservation so as to prevent wastage due to warping and cracking, and deterioration due to biological causes and fire, respectively.

Purpose of Wood Preservation—Timber offers, many advantages like ready availability; high strength, electrical insulation and sound absorption properties; high salvage value; low cost; low weight; low thermal conductivity; high specific heat; ease of working; amenability to improvement of its natural properties and elimination of weak points at knots by modern processes of delamination (slicing, peeling, etc.) and building up to any required size and/or shape. It however, lacks dimensional stability, and is prone to splitting and cracking, and is also liable to deterioration due to decay by fungi and attack by insects (borers), termites (white ants) and marine organisms, and fire, *vide* Plate 2. Data on the natural durability of about 200 species of timbers tested in the 'graveyards' at the Forest Research Institute (heartwood stakes $24 \times 2 \times 2$ inches are buried in the yard, in the open, up to half their height and their resistance to attack by insects, termites and fungi determined over a period extending

to several years) and about 56 species tested for fire resistance[15c] in the laboratory are given in Figure 2 and Table No. 7. It will be seen from the above that quite a large number of species, have low natural durability against deterioration due to biological causes and fire. Experience has shown that by suitable chemical treatment of timber its life can be increased to 5–10 times its normal life, and its fire resistive property increased by 2–8 times (*vide* Table No. 8; Plate No. 3). Prophylactic treatments can also be given to timber and bamboos to protect them from 3–6 months during transit and storage prior to their full-fledged preservative treatment, *vide* Plate No. 4. Timber can also be chemically treated to protect it from certain fungi causing blue, brown, etc., stains which lower the market value of timber. Thus wood preservation helps in the proper utilization of timber and in the conservation of our timber supplies and forests. The future scope of wood preservation for various items is given below :—

(1) *Railway sleepers*—The Railways all over the world, have always been the first to adopt wood preservation methods to protect their sleepers from rapid deterioration. India is no exception to this ; her railways had adopted wood preservation as early as in 1854. The Indian Railways have now a track of about 50,000 miles[22]. At the rate of about 2,000 sleepers per mile of track, the total requirements of sleepers for the whole track will be 100,000,000. At present only 50 per cent of these are wooden sleepers. Wooden sleepers, it may be remarked, give greater riding comfort to the passenger and greater life to the rolling stock because of their higher shock absorption property compared to metal sleepers. The metal sleepers, however, give longer service life and require less attention by the gang-men compared to wooden sleepers. Properly treated wooden sleepers have also given an average life of 20–25 years *vide* Table No. 9. This is considered satisfactory from an economic point of view. The results of treated half-round sleepers are of particular interest in this connection as more sleepers can be turned out from the same log by this way compared to rectangular sleepers. Therefore, the balance of advantages is towards the wooden sleepers provided they are suitably treated. Every effort needs to be made in future to replace all metal sleepers by wooden sleepers.

It is estimated that about 60,00,000[23] sleepers would be required annually for renewals and new lines during the next few years. To this may be added sleepers required by various industries and state forest departments for laying and maintaining their tramway lines. In all about 10 million sleepers would be required per year. Table No. 10 (*vide* App.), where details of the availability of sleepers are given, indicates that about 12 million sleepers (B.G., M.G., N.G. and half-round sleepers) can be made available. For treating the present demand of 60,00,000 sleepers about 15 commercial wood preservation plants, 10 big units with an annual capacity of 5,00,000 of sleepers and 5 small units of 2,00,000 sleepers should be put up. While most of them should be pressure treating plants, at least 2–3 can be open tanks, using the hot and cold process *vide* Table No. 11. For treating sleepers it is best to use creosote fuel-oil mixture (50 : 50) with an average absorption of 5 lbs./cu. ft. At present about 300 tons of creosote are being manufactured by Messrs. Shalimar Tar Products in India. If necessary the production of creosote can be increased from lignite coal in South India. As for fuel-oil, there is plenty of it available in the country, though most of it is imported. Recently, about a few hundred *chir*, *sain* and *chilauni* sleepers were treated with penta-chlorophenol and laid on the lines for experimental purposes. If these experiments prove successful, this preservative which is now imported, can also be manufactured in India.

At the instance of the Central Standards Office of the Railway Board, a fire proof-cum-antiseptic composition was developed in 1951 at the Forest Research Institute. This preservative was used to treat about 400 *chir* and 200 *sain* sleepers. The behaviour of these sleepers will be watched with keen interest.

TABLE No. 7

Rates of burning of timber species arranged in descending order of resistance tested at Forest Research Institute, Dehra Dun

GROUP I

1. *Hardwickia binata.* 2. *Diospyros* spp.

GROUP II

3. *Hopea parviflora.* 4. *Terminalia tomentosa.* 5. *Terminalia paniculata.* 6. *Eucalyptus globulus.* 7. *Shorea robusta* (sap.). 8. *Berrya ammonilla.*

GROUP III

9. *Bischofia javanica.* 10. *Chloroxylon swietenia.*

GROUP IV

11. *Borassus flabellifer.* 12. *Carapa moluccensis.* 13. *Artocarpus hirsuta.* 14. *Anogeissus latifolia.* 15. *Tectona grandis.* 16. *Quercus ilex.*

GROUP V

17. *Schima wallichii.* 18. *Acacia arabica.* 19. *Pinus longifolia.* 20. *Stereospermum chelonoides.* 21. *Toddalia bilocularis.* 22. *Diospyros.* spp. (sapwood). 23. *Lagerstroemia* spp. 24. *Dipterocarpus* spp. 25. *Pterocarpus marsupium.* 26. *Albizzia lebbek.* 27. *Pterocarpus dalbergioides.* 28. *Dalbergia sissoo.* 29. *Terminalia belerica.*

GROUP VI

30. *Prunus paddum.* 31. *Dalbergia latifolia.* 32. *Albizzia odoratissima.* 33. *Calophyllum tomentosum.* 34. *Cupressus torulosa.* 35. *Adina cordifolia.* 36. *Homalium tomentosum.* 37. *Cedrela toona.*

GROUP VII

38. *Juglans regia.* 39. *Hymenodictyon excelsum.* 40. *Tetramales nudiflora.* 41. *Terminalia bialata.*

GROUP VIII

42. *Picea morinda.* 43. *Swietenia* spp. 44. *Terminalia myriocarpa.* 45. *Mangifera indica.* 46. *Morus* spp. 47. *Pinus excelsa.*

GROUP IX

48. *Moringa* spp. 49. *Anthocephalus cadamba.* 50. *Bombax malabaricum.* 51. *Endospermum malaccense.* 52. *Erythrina indica.* 53. *Cryptomeria japonica.*

TABLE No. 8(*a*)

Serial No.	Preservative	Species	Treatment process	Absorption lbs. c. ft.	TREATED		UNTREATED	
					Service life obtained Yrs. Mths.	Condition	Service life obtained Yrs. Mths.	Condition
1	Shaw wallace creosote	*Boswellia serrata* ..	Open tank (heating for 1 hour cooling for 23 hours)	16·1	34 2	Bwf	1 5	Dw
2	Do.	*Pinus longifolia* ..	Do.	9·4	34 2	Bf	2 10	Dw
3	Do.	*Pinus excelsa* ..	Do.	3·4	24 1	Dw	9 11	Dw
4	Do.	*Picea morinda* ..	Do.	35·5	34 2	Bwf	2 10	Dw
5	Do.	*Abies pindrow* ..	Do.	8·07	34 2	Bwf	2 10	Dw
6	Do.	*Pterocarpus macrocarpus* ..	Do.	1·69	19 4	Dw	14 10 and then missing	Bw
7	Do.	*Bombax malabaricum* ..	Do.	11·5	34 2	Dwf	0 9	Dw
8	Do.	*Bauhinia retusa* ..	Do.	9·4	14 11	Df	1 5	Dw
9	Do.	*Dipterocarpus tuberculatus*	Do.	5·4	19 4	Dwf	5 1	Dw
10	Do.	*Anogeissus latifolia* ..	Do.	16·7	34 2	Bwf	2 10	Dw
11	Do.	*Odina wodier* ..	Do.	19·5	34 2	Df	2 10	Dw
12	Do.	*Shorea robusta* ..	Do.	1·2	14 11	Dw	11 0 and then missing	Mw

Legend :—

N = No attack.
Sw = Slight termite attack.
Sf = Slight fungus attack.
Mw = Moderate termite attack.
Mf = Moderate fungus attack
Bw = Bad termite attack.
Bf = Bad fungus attack.
Dw = Destroyed by termite.
Df = Destroyed by fungus.

TABLE NO. 8(*b*)

Serial No.	Species	Preservative	No. of specimens	Treatment process	Average Absorption lb./ per cu. ft. (dry salt)	TREATED Service life to-date Yrs.	Mths.	Nos.	Condition	UNTREATED Service life Yrs.	Mths.	Condition
1	*Pinus longifolia* (*chir*) ..	Ascu 8%	6	Pressure	0·84	16	7	3 3	N Sw	0	11	Dw
2	*Abies pindrow* (*fir*) ..	Do.	6	Do.	0·900	16	7	3 3	N Sw	4	5	Dw
3	*Pinus excelsa* (*kail*) ..	Do.	6	Do.	0·85	16	7	3 3	N Sw	8	4	Dw
4	*Cedrus deodara* (*deodar*) ..	Do.	6	Do.	1·13	16	7	6	N	13	11	Dw
5	*Terminalia myriocarpa* (*hollock*).	Do.	5	Do.	1·24	16	1	4 1	Sw Df	1	2	Dw
6	*Dipterocarpus macrocarpus* (*hollong*).	Ascu 4%	6	Do.	0·62	16	1	4 2	Sw Dw	1	8	Dw
1	*Pinus longifolia* (*chir*) ..	Creosote and fuel-oil (40 : 60)	2	Pressure (Lowry Process)	6·85	17	..	1 1 sent to exhibition	Sw	0	11	Dw
2	*Abies pindrow* (*fir*) ..	Do.	2	Do.	13·1	17	..	1 1	N Swf	4	5	Dw
3	*Pinus excelsa* (*kail*) ..	Do.	2	Do.	14·25	17	..	2	Sw	8	4	Dw
4	*Cedrus deodara* (*deodar*) ..	Do.	2	Do.	9·45	17	..	1 1	N Sw	13	11	Dw
5	*Terminalia myriocarpa* (*hollock*).	Do.	2	Do.	5·9	14	..	2	Df	1	2	Dw
6	*Dipterocarpus macrocarpus* (*hollong*).	Do.	2	Do.	5·35	17	..	1 1	Bwf Dwf	1	8	Dw

Legend :—

N = No attack.
Sw = Slight termite attack.
Sf = Slight fungus attack.
Mw = Moderate termite attack.
Mf = Moderate fungus attack.
Bw = Bad termite attack.
Bf = Bad fungus attack.
Dw = Destroyed by termite.
Df = Destroyed by fungus.

TABLE NO. 8(*c*)

Durability of Treated Timbers

Antiseptic : CELCURE Treatment Process : Pressure.

Received from : Mr. William Sandison, 110 East Clyde Street, Hetersburg, Scotland, Messrs. The Celcure and Chemical Co., Ltd., 41 Saw Mill Road, Glasgow.

Date laid down 17–3–1931.

Date of Inspection 24–1–1952.

Serial No.	Species	Absorption lbs./cu. ft. (Dry salt)	Condition of test piece on date of inspection					
			Treated			Untreated		
				Period Years	Months		Period Years	Months
1	*Pinus longifolia*	1·82	N	..	..	Dw	0	7
2	*Adina cordifolia*	1·12	Sw	..	..	Dwf	0	7
3	*Picea morinda*	0·92	Bw	..	..	Dw	1	7
4	*Abies pindrow*	1·75	Mw	..	..	Dw	0	4
5	*Bombax malabaricum*	1·77	Sw	..	..	Dw	0	7
6	*Schleichera trijuga*	2·16	Dwf	11	8	Dwf	2	8
7	*Terminalia tomentosa*	0·61	Dwf	5	10	Dw	2	8
8	*Albizzia procera*	1·71	Df	10	9	Dw	5	10

Legend :—

N = No attack.
Sw = Slight termite attack.
Mw = Moderate termite attack.
Bw = Bad termite attack.
Dw = Destroyed by termites.
Df = Destroyed by fungus.
Dwf = Destroyed by termites and fungus.

TABLE NO. 8(*d*)

Serial No.	Preservative	Species	Treatment Process	Absorption lbs./c. ft.	Service life obtained Treated Yrs. Mths.	Condition	Service life obtained Untreated Yrs. Mths.	Condition
1	Santophen 20 (5% solution in diesel oil).	*Pinus longifolia*	Pressure	1·08	12 ..	Mwf	4 ..	Dw
2	Do. ..	Do.	Do.	1·43	12 ..	Bw	4 ..	Dw
3	Do. ..	Do.	Do.	1·04	12 ..	Bw	1 9	Dw
4	Do. ..	Do.	Do.	1·04	12 ..	Bw	1 9	Dw
5	Do. ..	Do.	Do.	1·53	11 ..	Dw	3 1	Dw
6	Do. ..	Do.	Do.	1·4	12 ..	Bw	2 1	Dw
			Average of 6 specimens	1·25	11·83		2 9	
7	Do. ..	*Bombax malabaricum*	Pressure	·565	12 ..	Mf	1 9	Dw
8	Do. ..	Do.	Do.	·730	12 ..	Mf	1 9	Dw
9	Do. ..	Do.	Do.	·620	12 ..	Bf	1 9	Dw
10	Do. ..	Do.	Do.	·420	11 ..	Df	2 1	Dw
11	Do. ..	Do.	Do.	·520	12 ..	Bf	1 9	Dw
12	Do. ..	Do.	Do.	·535	12 ..	Bf	2 1	Dwf
			Average	·565	11·83 ..		1 10	

N = Sound.
W = White ant attack.
F = Fungus attack.
S = Slight attack.
M = Moderate attack.
B = Bad attack.
D = Destroyed.

TABLE No. 8(e)

Table showing the efficiency of Fire-proof Treatment

Serial No.	Species Tested	Composition used	Absorption in lbs./c. ft. (dry salt) under Lowry Process	Resistance to fire before treatment a	Resistance to fire after treatment b	Efficiency of treatment b/a	REMARKS
1	*Chir*	Ammonium Phosphate (dibasic).	1·2	11·03	89·2	8	The figures under "resistance to fire" indicate the percentage residual weight of timber after test by the well-known 'fire-tube' method. These values are the average of 6 tests in each case.
2	Mango	Do.	0·85	29·04	82·9	3	
3	*Chir*	Borax	1·1	11·03	79·9	7	
4	Mango	Do.	0·51	29·04	69·0	2·5	
5	*Chir*	Zinc Phosphate (monobasic).	1·41	11·03	81·2	7·5	
6	*Semul*	Do.	1·53	13·65	75·3	5·5	
7	Mango	Do.	1·2	29·04	62·1	2	
8	*Semul*	Fire - proof - cum - antiseptic composition developed at the Forest Research Institute, Dehra Dun.	6·24	13·65	74·4	5·5	
9	*Semul*		2·78	13·65	56·6	4	
10	*Chir*		7·96	11·03	80·8	7	
11	*Chir*		2·79	11·03	67·5	6	
			gms./sq. in.				
12	*Semul*	Fire-proof paint developed at the Forest Research Institute.	0·031	11·65	49·6	4	
13	*Chir*		0·037	11·03	48·5	4·5	
14	*Chir*	A proprietary paint tested	..	11·03	57·0	5	
15	Mango	Do.	..	13·65	58·3	4·0	

TABLE NO. 9—*Statement showing the service life of both*

Serial No.	Species of Timber	Size and number of sleepers laid down	Treated or untreated	Preservative used	Treatment process adopted	Absorption of preservative in lbs./cu. ft.
1	*Pinus longifolia* (*chir*) ..	152 B.G.	Treated	Powell solution	Open tank	Not known
2	Do. ..	100 B.G.	Do.	ASCU (8%)	Pressure	$\frac{3}{8}$ to $\frac{1}{2}$ lb. dry salt ($3/2 \pm \frac{1}{2}$ lbs. antisplit medium)
3	Do. ..	100 B.G.	Do.	Creosote and Earth Oil (40 : 60)	Do.	4·76
4	*Pinus* spp. ..	11 M.G.	Untreated	..	..	..
5	*Terminalia tomentosa* (*sain*)	131 B.G.	Treated	Powell solution	Open tank	Not known
6	Do.	250 M.G.	Untreated	..	..	..
7	*Terminalia myriocarpa* (*hollock*).	151 M.G.	Treated	Creosote and Creosote-Earth Oil (1 : 1) (1 : 2) (1 : 3)	Pressure	6·5–9·3
8	Do.	22 M.G.	Untreated	..	..	..
9	*Dipterocarpus macrocarpus* (*hollong*).	142 M.G.	Treated	Creosote and Creosote-Earth Oil mixture (1 : 1) (1 : 2) (1 : 3)	Pressure	4·9–11·1
10	*Lagerstrœmia flosreginæ* (*jarul*)	150 M.G.	Treated	Creosote and Earth Oil (1 : 1)	Do.	0·07–1·8
11	Do.	100 M.G.	Untreated	..	..	..
12	*Cedrus deodara* (*deodar*) ..	100 B.G.	Treated	ASCU (8%)	Pressure	$\frac{3}{8}$ to $\frac{1}{2}$ lb. dry salt ($3/2 \pm \frac{1}{2}$ lbs. antisplit medium)
13	Do. ..	100 B.G.	Do.	Creosote and Earth Oil (40 : 60)	Do.	3·30
14	*Shorea robusta* (*sal*) ..	46 M.G. (Half-rounds)	Treated	ASCU (8%)	Do.	..
15	Do. ..	300 M.G. (Half-rounds)	Do.	Creosote and Earth Oil mixtures (70 : 30) and (50 : 50)	Do.	..
16	Do. ..	100 M.G.	Untreated	..	..	..

treated and untreated sleepers in Indian Railways

Locality where laid	Date of laying	Date of last inspection	No. of sleepers alive	% replacement	Average life: Anticipated according to Madison curve	Average life: Calculated Years	Average life: Calculated Months
					Years		
Hardwar–Lakshar Section (E.I.R.)	Jan. 1912	Dec. 1927	Nil	100	..	15	5
Delhi Section (E.P.R.)	March 1937	May 1950	91	9	21	..	..
Do.	Do.	Do.	95	5	23	..	..
Mile 221, Burma Railways	Sep. 1907	Aug. 1909	Nil	100	..	2 (Approx.)	
Hardwar–Lakshar Section (E.I.R.)	Sep. 1911	Dec. 1927	Nil	100	..	15	5
Near Moriani (Assam Railway)	May 1914	Oct. 1922	17	94	6	..	..
Do.	Jan. 1925	Feb. 1951	Nil	100	..	19	10
Do.	Nov. 1915	Oct. 1922	Nil	100	..	5 (Approx.)	
Do.	Jan. 1925	Dec. 1942	61	51	19	..	..
Do.	May 1925	Feb. 1951	6	96	19	..	..
Do.	March 1918	Dec. 1923	87	13	7	..	..
Delhi Section (E.P.R.)	March 1937	May 1950	95	5	23	..	..
Do.	Do.	Do.	97	3	26	..	..
Mailani (O. & T. Rly.) and Mathura (B.B. & C.I.)	Feb.–March 1940	April–July 1951	46	Nil	..	11 (to-date)	2–4
Do.	Do.	Do.	299	0·3	..	Do.	
Near Moriani (Assam Railway)	Sep. 1919	Dec. 1923	91	9	7	..	..

TABLE NO. 11

Requirements of wood preservation plants for the treatment of railway sleepers

Serial No.	Location of plant	No. of Plants	Annual Capacity in Sleepers	Pressure or open tank plant	REMARKS
			lacs		
1	Dhilwan in Punjab State	1	5	Pressure plant	Already existing.
2	Dak Pathar in U.P.	1	2	Do.	Proposed.
3	Tanakpur in U.P.	1	5	Do.	Do.
4	Siliguri in W. Bengal	1	5	Open Tank	Do.
5	Naharkatiya in Assam	1	5	Pressure	Already existing.
6	Jharsuguda in Orissa	1	5	Open tank	Proposed.
7	Vishakhapatam in Madras	1	5	Pressure	Do.
8	Andamans	1	5	Do.	Do.
9	Quilon in Travancore	1	2	Do.	Do.
10	Coimbatore in Madras	1	5	Do.	Under erection.
11	Bhadravati in Mysore	1	5	Do.	Already existing.
12	Dandeli in Bombay	1	2	Do.	Proposed.
13	Balharshah in Hyderabad	1	5	Do.	Do.
14	Kota (near Bilaspur) in M.P.	1	2	Open Tank	Do.
15	Coorg	1	2	Pressure	Do.
	TOTAL ..	15	60 lacs		

(2) *Transmission poles, telegraph and telephone poles and piles*—In U.S.A. which is about 3 times as big as India about 6 million[7c] poles of all kinds and about 4 million piles are treated and used each year. In Germany about 3 million poles and piles are said to be used after preservative treatment. Even in Sweden about 2 lac poles are treated by the State Telegraph Department annually. In India hardly 10,000 poles are treated a year. The only two States that use, at present, treated poles on a large scale are Mysore and United States of Travancore and Cochin. The advantages of wooden poles for the above purpose requires no great elaboration. Experience in various parts of the world has clearly shown that from the point of view of both service, and economy the wooden pole for electric transmission, telephone and telegraph, etc., purposes is by far the best material. The high dielectric property of wood makes it, in addition, an ideal material for this purpose. As for marine piles, metal can hardly compete with wood as the former easily gets corroded within a short period. The state of metal fittings in the Bombay harbour can be seen in Plate No. 5. Since the service conditions of a pole that is buried in the ground are very severe (*vide* Plate No. 6) particularly in India, suitable preservative treatment is necessary. Further, as the material is generally used in the round form with a ring of sapwood which is non-durable, it is necessary to treat poles irrespective of the durability of their heartwood. Treatment of these poles is easy as compared to the treatment of rectangular railway sleepers containing a large portion of heartwood which in some species is difficult to treat because of the presence, in a pole, of a ring of sapwood, which is easy to treat. However, since the service data available on the treated poles is not quite large, it is best that only durable species and also species whose heartwood can be easily treated, are used in the near future. Both Ascu treated and creosoted poles have given satisfactory results at the Forest Research Institute, Test-Yard. (*vide* Table No. 12*a*). But, in view of the disagreeable appearance, tackiness and non-paintability of the creosoted poles, treated poles using water soluble preservatives of the fixed type are preferable. For the marine piles, the above disadvantages of creosote do not matter and, therefore, creosote may be used to treat them.

PLATE No. 5

State of metal fittings in sea (back waters) at Bombay.

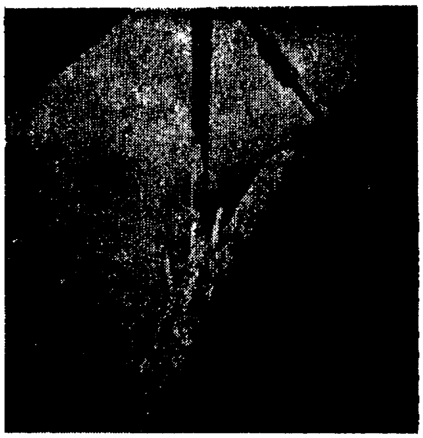


PLATE No. 6

Pillar of a shed hangs on to the roof fixtures after the bottom has decayed.

Shows the intensity of decaying conditions in tropics. Pillar at Bhadravati after 20 years service decayed completely below the ground level, even after creosote treatment. Proper absorption of the preservative and good depth of penetration are very essential. Several Ascu treated poles also failed in a short period in U.P. due to improper absorption and penetration of the preservative.

TABLE NO. 12(*a*)—*Statement of the condition of experimentally*

Serial No.	Species of timber used for poles	No. of poles in service	Preservative used	Treatment Process adopted	
1	2	3	4	5	
				PRESSURE	
1	*Pinus longifolia* (*chir*) ..	6 (20′ long)	ASCU (6%)	Lowry Process	
2	Do. ..	6 ,,	Creosote and Earth Oil (40 : 60)	Do.	
3	*Shorea robusta* (*sal*) ..	6 ,,	ASCU (6%)	Do.	
4	Do. ..	6 ,,	Creosote and Earth Oil (50 : 50)	Do.	
5	*Terminalia tomentosa* (*sain*) ..	6 ,,	ASCU (6%)	Do.	
6	Do. ..	6 ,,	Creosote and Earth Oil (50 : 50)	Do.	
7	Do. ..	1 ,,	Do.	Do.	
8	*Tectona grandis* (teak) ..	1 ,,	Do.	Do.	
9	*Casuarina equisetifolia* (*casuarina*)	9 ,,	Do.	Do. & Full Cell	
10	*Terminalia tomentosa* (*sain*) ..	4 (pieces)	Do.	Full Cell	
11	*Tectona grandis* (teak) ..	4 ,,	Do.	Lowry	
12	*Casuarina equisetifolia* ..	18 ,,	Do.	Lowry & Full Cell	
13	*Bruguiera* spp. ..	2 ,,	ASCU (2%)	..	
14	Do. ..	2 ,,	Creosote and Earth Oil (50 : 50)	Lowry & Full Cell	
15	*Anthocephalus cadamba* ..	1 ,,	Do.	Lowry	
16	*Michelia champaca* ..	4 ,,	Do.	Do.	
17	*Duabanga sonneratioides* ..	3 ,,	Do.	Do. & Rueping	
18	*Terminalia myriocarpa* ..	1 ,,	Do.	Do.	
				HOT AND COLD	
				Heating Period Hours	Cooling Period Hours
19	*Shorea robusta* (*sal*) ..	4 (20′ long)	Creosote and Earth Oil (50 : 50)	7·3/4	16
20	*Terminalia myriocarpa* (*hollock*)	4 ,,	Do.	8 to 10	16 to 40
21	*Michelia champaca* ..	2 ,,	Do.	5 to 6	18
22	*Cinnamomum cecidodaphne* ..	4 ,,	Do.	Do.	18
23	*Duabanga sonneratioides* ..	2 ,,	Do.	Do.	18
24	*Terminalia tomentosa* ..	10 ,,	Do.	6 to 10	18
25	*Chukrassia tabularis* ..	3 ,,	Do.	8 to 10	16 to 40
26	*Pinus longifolia* (*chir*) ..	4 ,,	Do.	4½ to 6	16 to 40
27	*Bruguiera* spp. ..	2 (pieces)	Do.	10	16
28	*Terminalia tomentosa* (*sain*) ..	12 (20′ long)	Do.	6 to 7	16 to 40
29	*Tectona grandis* (teak) ..	12 ,,	Do.	6	16
30	*Casuarina equisetifolia* (*casuarina*)	1 ,,	Do.	7	40

treated poles installed at the Forest Research Institute Test Yard

Absorption of the preservative in lbs./cu. ft.	Date of Installation	Condition on March, 1952	
		Nos. sound	Nos. attacked
6	7	8	
TREATMENT			
0·78–1·25 (Average 0·929)	October, 1937	All sound	
5·0–15·0 (Average 9·7)	Do.	5 sound	1 very slightly attacked by fungus below ground level.
0·31–0·49 (Average 0·44)	December, 1938	All sound	
3·8–5·4 (Average 4·4)	Do.	2 sound	4 slightly attacked by fungus below ground level.
0·33–0·47 (Average 0·38)	Do.	All sound	
1·5–3·7 (Average 2·4)	Do.	3 sound	3 slightly attacked by fungus below ground level.
3·3	March, 1943	All sound	
2·2	Do.	Do.	
2·6–7·3 (Average 5·5)	July, 1946	Do.	
3·5–4·1 (Average 3·8)	March, 1943	Do.	
1·5–2·4 (Average 2·0)	Do.	Do.	
3·3–10·3 (Average 7·1)	July, 1946	Do.	
..	March, 1942	Do.	
5·6–8·4 (Average 7·0)	Do.	Do.	Only up to 6 inches at the pith from the bottom is attacked by fungus.
19·6	February, 1942	Do.	
12·2–23·1 (Average 18·1)	March, 1942	Do.	
7·2–20·2 (Average 15·3)	Do.	Do.	
5·2	April, 1942	Do.	
TREATMENT			
5·3–8·1 (Average 6·4)	February, 1942	All sound	
11·1–14·9 (Average 13·2)	March, 1942	Do.	
20·9–24·5 (Average 22·7)	Do.	Do.	
10·2–13·3 (Average 14·2)	Do.	Do.	
19·1–19·6 (Average 19·4)	Do.	Do.	
3·0–5·6 (Average 4·1)	February, 1942	Do.	
2·9–4·6 (Average 3·5)	Do.	2 sound	1 slightly attacked by white ant and fungus below ground level.
17·9–24·3 (Average 27·0)	March, 1942	All sound	
7·2–7·7 (Average 7·5)	April, 1942	Do.	
2·6–4·5 (Average 3·8)	March, 1943	Do.	
1·4–2·6 (Average 2·0)	Do.	11 sound	1 slightly attacked by fungus below ground level.
11·9	July, 1946	All sound	

It is rather difficult to estimate the requirements of both poles and piles in India. But in view of the developments of hydroelectric schemes all over the country and improvements of coastal navigation, heavy demand for wooden poles and piles may be expected. At least 5 lac poles annually for the next five-year period will be required for electrifying our towns and villages. But to electrify all our towns (2,703) and villages (6,55,892) about 3 million poles are wanted. A lac of piles annually, will be our demand for all our harbours including the new ones to be built in the future. Another lac of piles will be required for use in bridge constructions over canals and rivulets, if proper roads are to be built connecting the villages with the towns. It is only by making available the facilities of both electric power and proper roads links, that rural uplift work can make any headway in our country. For all this purpose large plantations of pole yielding trees have to be raised both in the forests and in our waste lands particularly along the coast, where *Casuarina* grows quite fast. When electric power is made available for household use, the present demand on *Casuarina* for fuel purposes will cease and most of it will be available for poles.

While pressure impregnation of poles is desirable, it has also been found that the Boucherie process gives fairly satisfactory results for the treatment of sapwood of certain species whose heartwood is durable. Apart from this, the advantages in the use of this method are :—

(1) quick treatment of timber in green condition which eliminates not only seasoning of the timber before treatment but also ensures against any decay or insect attack during the seasoning period ;

(2) elimination of the costly – pressure treating equipment ;

(3) on the hills where it is not possible to take heavy equipment this is the only practical method of treating poles ;

(4) while this method can be adopted for the treatment on a commercial scale, it can also be recommended for the treatment of a small number required for individual use ; and

(5) the treatment of bamboo is best done by this method, if it is to be used in the round form.

The Osmose method described earlier can also be used.

A pressure treating cylinder 8 feet in diameter and 45 feet long generally takes 30 transmission poles per charge which works out to 81,000 poles per year working 3 shifts a day for 300 days, if a water soluble preservative like Ascu is used. With creosote, however, only 30,000 poles can be treated in the above plant since heating of the preservative, which is required, takes considerable time. A plant to treat 30,000 poles using creosote is being put up in the Andamans.

For further details, on the poles like suggested species, their availability and their sizes, reference may be made to App. Tables 13*a*, 13*b* and 13*c*.

About 10 pressure treating plants with 6 to 8 feet cylinder diameter, 5 open tanks, and 7 Boucherie treating plants will be our requirements in the next 5 years for the treatment of about 8–10 lac poles, piles and fence posts of all sizes, *vide* Table No. 13*d*.

(3) *Treated timber for other constructional purposes*—A large quantity of timber, bamboos, and grasses is required for house building purposes. In the past only durable species like teak, *sal* and *deodar* were used for the purposes. These are not now available in the required quantities. Therefore, attention was turned to the non-durable timbers after preservative treatment. The water soluble preservatives of the leachable and fixed types are ideal for this purpose. The results have been satisfactory. It is possible to treat beams, windows and door frames, ceiling timbers, shingles for the roof, and paving blocks for the floor and expect an average life of 60–70 years under favourable conditions, and 40–50 years under adverse conditions. Further, by suitable designing, as in the wooden disc dowell joints,

TABLE No. 13(*d*)

Requirements of wood preservation plants for the treatment of transmission, telegraph and telephone poles

PRESSURE TREATING PLANTS

Serial No.	Place	No. of plants	REMARKS
1	Travancore State ..	3	Already existing
2	Mysore	1	Do.
3	Andamans	1	Sanctioned
4	Coorg	1	Proposed
5	Bombay	1	Do.
6	Assam	1	Do.
7	Madras	1	Do.
8	Madhya Pradesh ..	1	Do.
9	Uttar Pradesh ..	1	Do.
	TOTAL ..	10	

OPEN TANK TREATING PLANTS

Serial No.	Place	No. of plants	REMARKS
1	Bihar	1	Proposed
2	Orissa	1	Do.
3	Punjab	1	Do.
4	Uttar Pradesh ..	1	Do.
5	W. Bengal	1	Do.
	TOTAL ..	5	

BOUCHERIE TREATING PLANTS

Serial No.	Place	No. of plants	REMARKS
1	Kodaikanal	1	Proposed
2	Ooty Hills	1	Do.
3	Assam (Shillong) ..	1	Do.
4	U.P. Hills (Naini Tal) ..	1	Do.
5	Himachal Pradesh ...	1	Do.
6	Kashmir	1	Do.
7	Nepal	1	Do.
	TOTAL ..	7	

NOTE.—The capacity of each plant and the exact place where it should be located will be decided after consultation with the State Forest, Electricity and Post and Telegraph Departments.

thinner and shorter members of inferior woods like *chir*, mango, etc., can be used for roof trusses, *vide* Plate No. 7.

In view of the sudden heavy demand for houses due to rapid industrialization of the country and the influx of people from parts of India ceded to Pakistan, the need to develop cheap and efficient material for house building purposes, became very important. Experiments, were, therefore, conducted to utilize bamboos, grasses and palmyra. It is now possible to treat half split bamboos and use them to make corrugated roofs, split bamboos meshed in wooden frames and afterwards plastered with mud or with cement concrete to serve as walls ; grasses used for thatching purposes after soaking in preservative chemicals have shown, after two years of exposure to rain and heat, the freshness of the new material. An average life of 7–10 years can be expected of this treated grass ; but, if pressure impregnation is adopted, the service life can be considerably increased. Palmyra split into halves was impregnated with preservatives, after scooping out the centre pith, and used as ridge tiles. These can be expected to give an average life of over 25–30 years. The advantage of wood paving blocks in a house under conditions of extreme cold and heat is well known. Further properly constructed timber floors last better under abrasion in godowns and give the necessary spring in rinks, squash courts, ball-rooms, etc. Properly treated timber for floors has already given satisfactory service in U.S.A., and limited tests done in India indicate that similar results can be expected even in this country. Treated pale fencing using both rejected timber in the saw-mills and split bamboos is not only economical but is also advantageous in a number of ways : it can be erected in a short time ; takes very little space ; protects the garden against ravages by hares since the treated material can be safely projected in the ground ; perennial creepers can be made to spread over it because the preservative is not injurious to growth of plant life ; and lastly the fence can be quickly shifted from one place to another with ease.

It is also possible to treat laminated structures and plywood with preservative chemicals to ensure protection against decay and insects. Large scale treatments of glued up timber is already in progress in U.S.A. and Canada. Limited experiments have indicated that satisfactory results can be obtained in India also.

In all building works, care should be taken to provide dampproof foundations and anti-termite metal shields. The latter is easily done by fixing metal shields bent at an angle of 45° downward and projecting at least 3 inches beyond the piers or the foundation walls. This will give added protection to the building and will ensure against entry of termites into timber parts. If, however, termite attack is noticed in any building either the source of entry is completely plugged off with cement mortar, or the termite colony is dusted with Paris green or Cowan's powder. The insects carry the poisonous powder, and in their grooming habit spread it to the whole colony which finally perishes. The Cowan's process is carried out in India by Messrs. Jarding Henderson Ltd., 4 Clive Row, Calcutta.

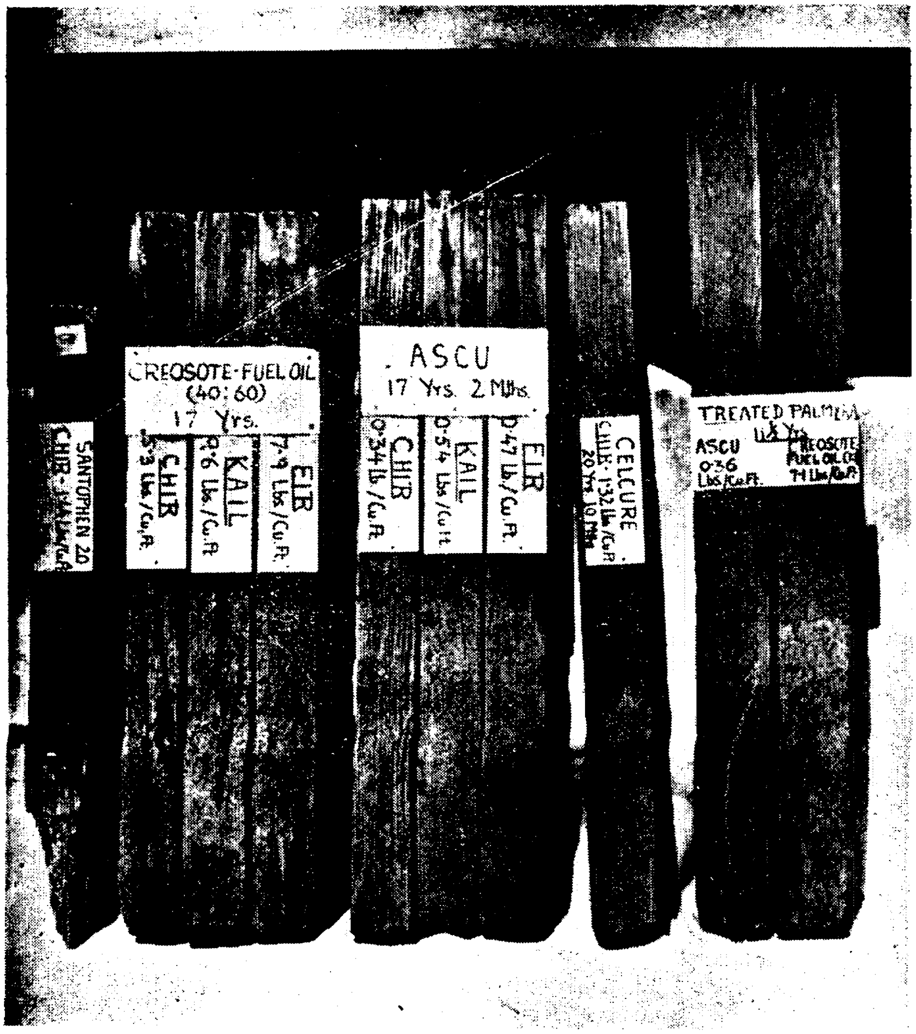
The number of Wood Preservation Plants required for treatment of timber for constructional purposes is given in Table No. 14.

(4) *Treatment of timber for furniture, packing cases, etc.*—With the increase of migration of population to towns and cities, the demand on furniture has increased. Again with the industrialization of the country there is a very heavy demand for packing cases made of solid timber and plywood. There is also a very great demand for ammunition boxes by the Defence Department. Both softwood and heartwood species of low durability are being used for the above purpose. Preservative treatment of these timbers, has therefore, assumed great importance. Since the conditions of deterioration of the above timbers are not very severe, experiments were conducted with low pressure treatment using both the water-soluble preservatives and toxic chemicals dissolved in organic solvents. Using the apparatus shown in Fig. 5, it was found that satisfactory absorption and penetration of the preservative can be obtained in the pressure range 25–50 lbs./sq. in. The apparatus costs about Rs. 5,000 for a 12 feet

PLATE No. 3

Preservative treatment of timber pays better dividends than insurance — it gives *long life* !

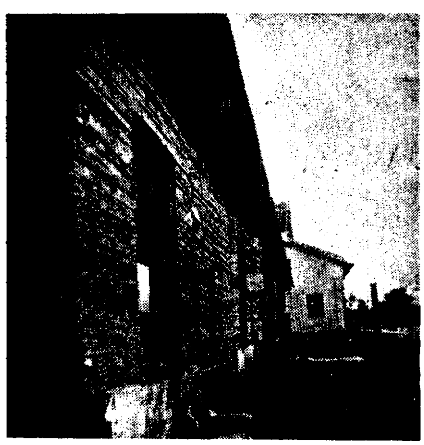
3/1



Treated specimens still in sound condition after several years exposure in the 'Graveyard'. The extreme left specimen is attacked by termites and fungi only up to 6″ from the bottom.

3/2

3/3



Ascu treated bamboo walls after 14 years service at Bhadravati.

3/4

Creosoted sleepers undergoing tests at Edaman in the South. Fungus attack is very severe in this locality.

PLATE No. 4(*a*)

Decay of timber in depots causes as great a damage to our timber stocks as infantile paralysis to our **manpower.**

4(*a*)/1
Shows improper stacking of sawn timber at Dandeli Depot.

4(*a*)/2
Shows improper stacking of sleepers at Tanakpur Depot.

4(*a*)/3
Several thousands of sleepers are lost due to decay at Tanakpur Depot.

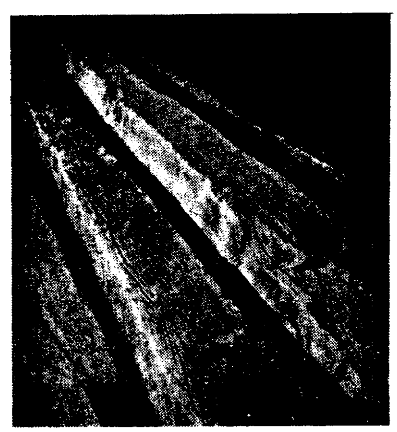
4(*a*)/4
Decayed sleeper at Tanakpur Depot.

Sleepers are properly stacked by one-in-nine method at Bhadravation treated skids. 4(*a*)/5

Experiments on prophylactic treatments at Ramnagar.
4(*a*)/6 4(*a*)/7

Shows that money spent on sheds to store timber waiting for treatment at preservation plants pays high dividends, since they are saved from decay during storage.

Experiments on prophylactic treatment of *chir* sleepers. Treated ones are sound after 6 months.



Fungal attack on untreated sleepers.

PLATE No. 4(*b*)

Prophylactic treatment of timber pays quick dividends !

4(*b*)/1

While the treated *semul* log on the left half is sound after 6 months exposure to rain, the right half left with the bark on is heavily decayed – tests at F.R.I.

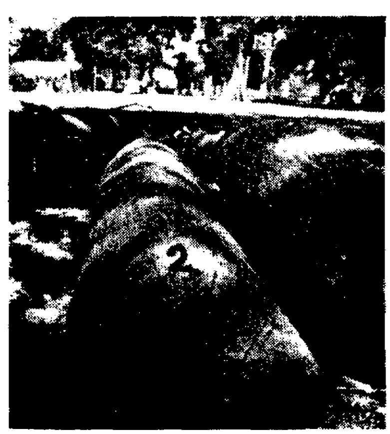
4(*b*)/2

4(*b*)/3

Both debarked and underbarked logs of *semul* decay in 2–3 months during rainy season – tests in Lalkua.

4(*b*)/4

4(*b*)/5

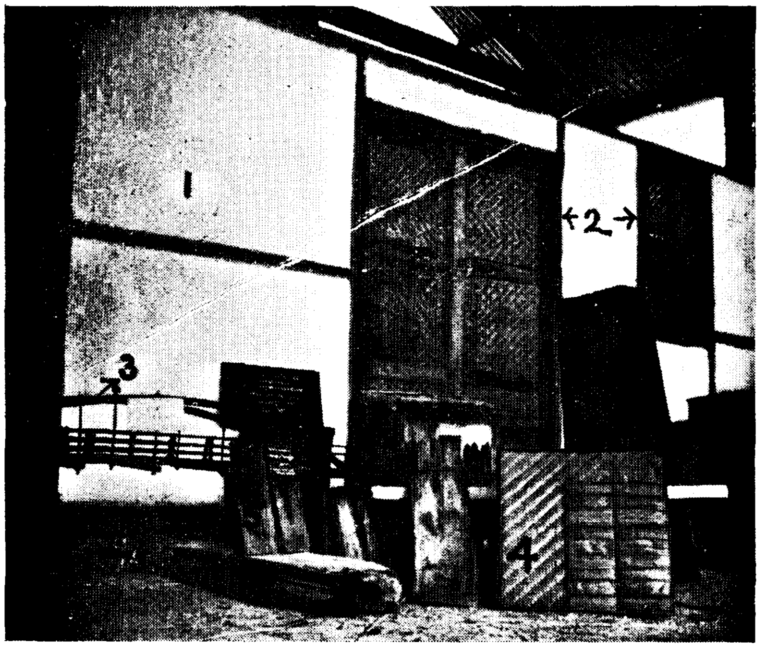


Treated *semul* logs No. 1, 2 and 3 were free from fungal attack in tests at Lalkua.

PLATE No. 7

Treated timber, grasses and bamboos offer cheap building material.

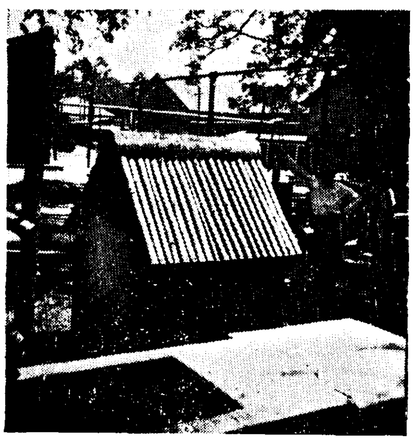
7/1

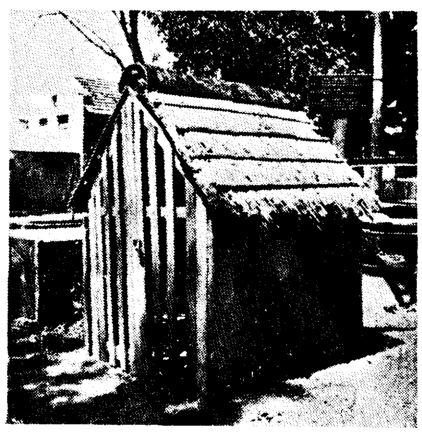


(1) Treated bamboos reinforced mud wall, (2) treated bamboo mat makes good panels for doors and windows, (3) Model of a treated bridge constructed of laminated timber, (4) treated banana bark makes good partition wall, (5) treated shingles can also be dyed.

7/2 After two years tests in the open. 7/3

(1) Treated palmyra makes good ridge tile, (2) treated half split bamboos makes good roof.



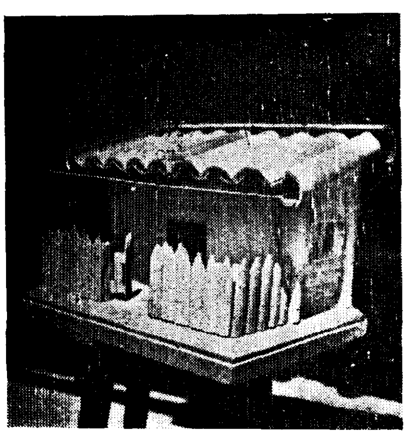


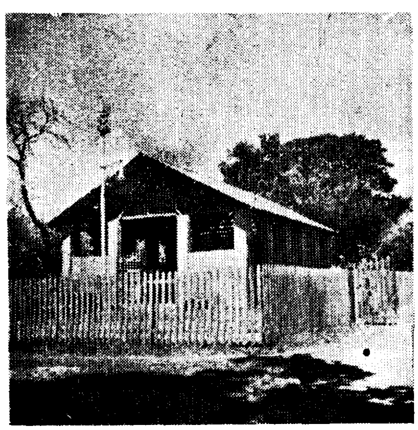
(1) Treated grass for the roofing, (2) Treated bamboo reinforced mud wall, after plastering with treated saw-dust does not get wetted during rainy season.

7/4

7/5

Method of using treated bamboos for corrugated roofs.





(1) Treated *chir*, *Bridelia retusa* trusses and mango purlins.

(2) Treated *chir*, *fir*, *spruce* and *kail* makes good pale fencing.

long and 3 feet diameter cylinder along with accessories and can be had locally from Messrs. Shalimar Tar Products (1935) Ltd., 6 Lyons Range, Calcutta or Ascu Wood Products Ltd., 6 Mangoe Lane, Calcutta.

For treatment of plywood for tea-chests against *Lyctus* borers the only suitable preservative so far found satisfactory is boric acid and/or borax. The treatment consists of dipping the veneers in a hot (120–200°F.) solution of the preservative kept in a copper tank. Generally a 5 per cent solution of borax or 1·25 per cent solution of boric acid in water is recommended. The period of dipping in the preservative depends upon the species of timber, its moisture content, and thickness of the veneers.

A map of India showing the existing and proposed Wood Preserving Plants, as given above, is shown in Fig. 3.

TABLE No. 14

Requirement of pressure treating plants for constructional (house building, bridges, etc.) timbers

Serial No.	State	Proposed Location
1	Madras	Madras
2	Do.	Coimbatore
3	Do.	Vijayawada
4	Do.	Vishakhapatnam
5	Mysore	Bangalore
6	Do.	Mysore
7	Travancore-Cochin	Mattancheri or Ernakulam
8	Bombay	Bombay
9	Do.	Ahmedabad
10	Do.	Poona
11	Do.	Baroda
12	Hyderabad	Hyderabad
13	Madhya Pradesh	Nagpur
14	Do.	Jubbulpore
15	Orissa	Bhubaneswar
16	Do.	Mayurbhanj
17	Bihar	Patna
18	West Bengal	Calcutta
19	Uttar Pradesh	Lucknow
20	Do.	Gorakhpur
21	Do.	Etawah
22	Assam	Gauhati
23	Punjab	Amritsar
24	Do.	Chandigarh
25	Delhi	Delhi
26	Kashmir	Srinagar
27	P.E.P.S.U.	Patiala
28	Saurashtra	Junagadh
29	Rajasthan	Jaipur
30	Bhopal	Bhopal
31	Himachal Pradesh	Paunta
32	Vindhya Pradesh	Rewa

NOTE.—The capacity of each plant will be decided after consultation with the State Public Works Departments.

(*To be continued*).

INDIGENOUS CELLULOSIC RAW MATERIALS FOR THE PRODUCTION OF PULP, PAPER AND BOARD

PART XIII.—CHEMICAL PULPS AND WRITING AND PRINTING PAPERS FROM *TREMA ORIENTALIS*, BLUME

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SUMMARY

Laboratory experiments on the production of chemical pulps by the sulphate process from the wood of *Trema orientalis* are described. Pilot plant experiments on the preparation of writing and printing papers from this wood are also included. This investigation has shown that chemical pulps in satisfactory yields can be prepared from this wood and these pulps can be utilized in admixture with about 25–40% of a long-fibred pulp such as bamboo pulp for the production of writing and printing papers. Two samples of paper are appended in this bulletin. One of them is a writing paper made from a stock containing 75% of *T. orientalis* pulp and 25% of bamboo bleached pulp and the other is a printing paper made from a stock consisting of 60% *T. orientalis* pulp and 40% of bamboo pulp.

INTRODUCTION

Trema orientalis, Blume, is a small, fast-growing and short-lived tree[1]. It is known by the name *kargol* in Marathi and *gorklu* in Kannada. It is found in sub-Himalayan tract and lower Himalayan region from the Jumna eastwards, Central, Western and Southern India except in the very dry tracts, Assam, Eastern Bengal and Chittagong. It is common in Ceylon. This tree is almost always, in the country it prefers, the first woody plant to appear in forest clearings, on fallow land, on landships or on banks, in fact wherever it has a chance[1]. Its growth is extremely fast. As this species is found on a large scale in Bombay State, the Conservator of Forests, Utilization and Engineering Circle, Bombay State, requested this Institute to test this wood for its suitability for mechanical pulp for newsprint and chemical pulp for writing and printing papers. The results of the investigation on the production of chemical pulps and writing and printing papers from this wood are described in this bulletin.

THE RAW MATERIAL

The Divisional Forest Officer, North Thana, Bombay State, arranged the supply of the wood (4 tons) for this investigation from Palghar and Sanjan ranges. The supply consisted of stem wood and branch wood. The logs from the stem wood were $9\frac{1}{2}$–$11\frac{1}{2}$ feet in length and 4–9 inches in diameter and those from the branch wood $13\frac{1}{2}$–15 feet in length and $1\frac{1}{2}$–4 inches in diameter. The logs were received without bark. The colour of the wood was light reddish-brown. The logs were chipped in the factory chipper of this Institute and screened on the factory screen. The screened chips were used for the laboratory as well as the pilot plant experiments.

PROXIMATE CHEMICAL ANALYSIS

The chips from the stem wood were reduced to dust. The dust passing through 60 mesh and retained on 80 mesh was used for the proximate chemical analysis employing the TAPPI standard methods. The results of the proximate analysis are recorded in Table I.

TABLE I

Proximate chemical analysis of the wood of Trema orientalis

		% on the oven-dry basis except moisture
1.	Moisture	7·72
2.	Ash	0·56
3.	Cold water solubility	1·38
4.	Hot water solubility	3·16
5.	1% NaOH solubility	21·50
6.	10% KOH solubility	34·64
7.	Ether solubility	0·87
8.	Alcohol-benzene solubility	1·19
9.	Pentosans	18·52
10.	Lignin	24·96
11.	Cellulose (Cross and Bevan)	57·50

From these results it will be seen that the cellulose content of this wood is satisfactory for its utilization for the production of paper pulp.

FIBRE DIMENTIONS

The measurements of the length and diameter of the fibres from the chemical pulp from the stem wood were made by the procedures usually followed in this laboratory. The average fibre length of the pulp was found to be 1·05 mm. the minimum and maximum values being 0·66 mm. and 1·44 mm. respectively. The values for the fibre diameter varied from 0·0122 mm. to 0·0352 mm. with an average of 0·0286 mm. The ratio of the average fibre length to diameter was 37 : 1.

PRODUCTION OF PULP

A number of digestions were carried out on a laboratory scale by the sulphate process using caustic soda and sodium sulphide in the ratio of 2 : 1. Chips from the stem wood were used for these laboratory experiments. The digestions were carried out with 22–26% of chemicals on the weight of the oven-dry chips. The temperature of the cooking was varied from 142° to 170°C. In some experiments the period of cooking was 4 hours and in others 6 hours.

The digestions were carried out in a vertical stationary cast iron autoclave which was heated from outside by means of gas burners. For each digestion 200 g. of chips (on the basis of the oven-dry weight) were used. After the cooking was over, the pulp was washed and bleached in two stages with an intermediate treatment with 2% caustic soda (on the weight of the oven-dry pulp) at 70°C. for 1 hour. After bleaching, the pulp was beaten in the Lampen Mill till the required freeness was obtained. Standard sheets were made and were tested for strength properties after conditioning at 65% R.H. and 88°F.

The conditions of digestions, the pulp yields, bleach consumption and strength properties of standard pulp sheets are recorded in Table II.

PILOT PLANT TRIALS

In order to confirm the results of the laboratory experiments regarding the suitability of this wood for the production of bleached chemical pulps for writing and printing papers, three pilot plant digestions were carried out using each time wood chips equivalent to about 650 lbs. on the oven-dry basis of the raw material. The chips from the stem wood and branch wood were mixed together in the proportion of 60% of the former to the 40% of the latter by weight in two experiments. In one experiment only branch wood was used for the digestion. The pilot plant machines described in an earlier publication[2] were used. The bleaching was carried out in two stages without the intermediate alkali treatment. Bleaching powder was used for bleaching the pulp. After the pulp was beaten to the requisite freeness, rosin size, alum and china clay and titanium oxide were added. In the case of the pulp obtained entirely from the branch wood, a portion of the furnish was run without admixture with bamboo beaten pulp. As the paper could not run smoothly on the paper machine and as the tear was low, bamboo beaten pulp was added to the furnish in the proportion 25% of pulp to 75% of *Trema orientalis* pulp and writing paper was made. This addition of the bamboo pulp helped in the smooth running of the paper on the machine. Pulps obtained in the other two digestions were used in making printing papers. In one case 60% of *Trema orientalis* pulp was mixed with 40% bamboo beaten pulp and in the other these two pulps were mixed in the ratio of 50 : 50.

The conditions of digestions, pulp yields and bleach consumption of the pilot plant experiments are given in Table III and the strength properties of the papers made from these in Table IV. A sample of the writing paper made from a mixture of 75% *Trema orientalis* pulp and 25% bamboo pulp is inserted in this bulletin. A sample of printing paper made from a mixture of 60% *T. orientalis* pulp and 40% of bleached bamboo pulp is also appended.

DISCUSSION

The results recorded in Table II indicate that well-cooked pulps can be prepared from the wood of *Trema orientalis* by the sulphate process using suitable digestion conditions. Under the conditions studied the digestion of the wood chips with 22% (on the basis of the oven-dry raw material) of chemicals in a concentration of 45 g./litre at 153°C. for 6 hours yields pulp with the maximum strength properties. The yield of the bleached pulp and the bleach consumption are also satisfactory in this case.

When the digestion is carried out with 22% (on the basis of the oven-dry raw material) of chemicals for 6 hours, the yields and strength properties of bleached pulps decrease with increase in the temperature of cooking from 153° to 170°C. At 170°C. over-cooked pulp is obtained. If the period of cooking is reduced from 6 to 4 hours at 153°C., the resultant pulp contains shives.

The decrease in strength properties of pulps with increase in the temperature of cooking from 153° to 162°C. is also observed in the case of digestions where 24% and 26% of chemicals are used. When these greater quantities of chemicals were used, the cooking was not carried out at 170°C. because over-cooked pulp in lower yield and with lower strength properties was obtained with 22% of chemicals for the digestion at this temperature.

From the results of the pilot plant experiments recorded in Table III it is clear that bleached pulps in good yields can be prepared from the wood of *Trema orientalis* by the sulphate process. Since these pulps are short-fibred, it is necessary to mix the pulp from this species with a long-fibred pulp such as bamboo pulp to produce writing and printing papers of satisfactory strength properties especially the tear. The bleached pulp from *T. orientalis* was not so white and bright as that from bamboo or from hardwoods like wattle wood.

TABLE II.—*Sulphate digestions of the wood of Trema*

DIGESTION CONDITIONS AND PULP YIELDS

1	2	3	4	5	6	7	8	9
Serial No.	Total chemicals* (NaOH : $Na_2S=2:1$)	Concentration of chemicals	Digestion temperature	Digestion period	Consumption of chemicals*	Unbleached pulp yield*	Bleach consumption as standard bleaching powder containing 35% available chlorine*	Bleached pulp yield*
	%	g./litre	°C.	hours	%	%	%	%
1	22	45	153	4	19·2	57·7	8·4	52·3
2	22	45	153	6	19·0	55·5	7·9	51·4
3	22	45	162	6	20·5	55·5	9·0	48·9
4	22	45	170	6	20·4	52·6	8·2	47·0
5	24	49	153	4	21·7	55·6	9·5	52·9
6	24	49	153	6	20·8	51·5	8·6	49·7
7	24	49	162	4	21·8	56·9	9·2	53·9
8	24	49	162	6	22·0	52·9	6·7	50·6
9	26	65	142	6	17·2	57·0	8·0	51·9
10	26	65	153	4	20·7	55·0	8·6	52·9
11	26	52	153	4	20·0	55·8	8·8	52·7
12	26	65	153	6	18·6	54·4	7·2	48·0
13	26	65	162	6	20·6	49·0	7·0	45·3

* The % is expressed on the basis of the raw material (oven-dry).

† Expressed on the basis of magnesium oxide = 100. The Photoelectric Reflection Meter Model 610 was used for determining the brightness.

orientalis and strength properties of standard pulp sheets

STRENGTH PROPERTIES OF STANDARD PULP SHEETS CONDITIONED AT 65% R.H. AND 88°F.

10	11	12	13	14	15	16	17	18
Freeness of pulp	Basis weight	Breaking length	Stretch	Tear factor (Marx-Elmen-dorf)	Burst factor (Ashcroft)	Folding endurance (Schopper)	Bright-ness†	REMARKS
c.c. (C.S.F.)	g./sq. metre	metres	%			double folds		
350	60·8	6400	2·6	79·4	52·0	640	54	A few shives were present in the unbleached pulp. The bleached pulp had a yellow tint.
280	62·0	7740	2·8	83·3	56·1	610	57	No shives. Bleached pulp was white.
•360	59·6	7780	2·6	77·4	48·1	180	57	Well-cooked pulp.
360	60·4	6890	2·9	53·6	39·4	60	57	Slightly over-cooked pulp. The bleached pulp had a yellow tint.
300	62·0	7170	2·6	74·2	57·7	520	58	Well-cooked pulp.
320	59·6	6940	2·8	70·3	48·9	380	54	Well-cooked pulp.
350	62·0	6510	2·6	72·5	45·9	310	58	Well-cooked pulp.
250	60·8	5590	2·4	68·2	46·2	150	56	Well-cooked pulp.
320	62·2	5910	2·5	65·4	45·7	130	60	Shives were present but these were bleached.
330	59·4	5700	2·3	59·0	37·5	50	60	Well-cooked pulp. No shives.
270	62·0	6600	2·5	72·5	49·6	620	..	Well-cooked pulp.
360	59·2	5640	2·3	54·6	40·7	70	58	The bleached pulp had yellow tine.
330	61·4	4710	2·0	35·3	26·4	10	60	Slightly over–cooked. The bleached pulp had a yellow tint.

TABLE III.—PILOT

Sulphate digestions of Trema

1	2	3	4	5	6
Serial No.	Total chemicals* (NaOH : Na_2S=2 : 1)	Concentration of chemicals	Digestion temperature	Digestion period	Consumption of chemicals*
	%	g./litre	°C.	hours	%
1	24	45	162 for the first 3 hours and 153 for the remaining period	6	22·5
2	22	45	153	6	20·1
3	24	45	153	6	..

* The % is expressed on the basis of the raw material (oven-dry).

TABLE IV.—PILOT

Strength properties of papers from pulps described in Table III. Serial Nos. in this Table

1	2	3	4	5	6		7		8	
Serial No.	Freeness after the addition of size, etc.	Ream weight 17½" × 22½" — 500	Basis weight*	Thickness	Tensile strength (Schopper)		Breaking length*		Stretch	
	c.c. (C.S.F.)	lb.	g./sq. metre	mils (1/1000 inch)	kilograms breaking strain for 1 cm. width		metres		%	
					Machine direction	Cross direction	Machine direction	Cross direction	Machine direction	Cross direction
1a	127	23·3	77·0	4·05	2·96	1·76	3840	2290	1·7	2·5
1b	150	22·3	73·7	3·75	2·91	1·38	3950	1870	1·7	2·5
2	100	21·8	72·1	3·75	3·74	1·71	5190	2370	2·4	3·8
3	186	18·9	62·6	3·55	3·09	1·43	4940	2280	2·0	3·9

* In calculating this, oven-dry weight of the paper was used.

† Expressed on the basis of magnesium oxide = 100. The Photoelectric Reflection Meter Model 610 was used for determining the brightness.

PLANT TRIALS
orientalis and pulp yields

7	8	9	10
Unbleached pulp yield*	Bleach consumption as standard bleaching powder*	Bleached pulp yield*	REMARKS
%	%	%	
50·8	9·9	46·9	Branch wood was used. Well-cooked pulp was obtained.
53·8	11·4	49·8	A mixture of 60% of stem wood and 40% of branch wood was used. Well-cooked pulp was obtained.
..	10·1	..	..

PLANT TRIALS
correspond to the Serial Nos. in Table III. The papers were conditioned at 65% R.H. and 70°F.

9		10		11	12	13		14	15
Tearing resistance (Marx-Elmendorf)		Tear factor*		Bursting strength (Ashcroft)	Burst factor*	Folding resistance (Schopper)		Brightness†	REMARKS
g.				lb./sq. inch		double folds			
Machine direction	Cross direction	Machine direction	Cross direction			Machine direction	Cross direction		
25·3	26·2	32·9	34·0	17·8	16·3	6	4	72	Printing paper from 100% *kargol* pulp.
31·4	35·4	42·6	48·0	17·3	16·5	11	6	74	Writing paper from a mixture of 75% *kargol* pulp and 25% bamboo pulp.
41·8	46·3	58·0	64·2	27·1	26·4	64	27	72	Printing paper from a mixture of 60% *kargol* pulp and 40% bamboo pulp.
40·4	46·9	64·5	74·9	20·2	22·7	42	16	72	Printing paper from a mixture of 50% *kargol* pulp and 50% bamboo pulp.

CONCLUSIONS

1. Bleached pulps in 46·0–49·8% yield can be prepared from the wood of *Trema orientalis* by the sulphate process. These pulps are short-fibred, the average fibre length being about 1 mm.

2. The bleached pulp from this wood can be used for the production of writing and printing papers by admixture with a long-fibred pulp such as bamboo pulp. The paper made from the pulp of this wood, however, is not so white and bright as that from bamboo.

Thanks are given to the Conservator of Forests, Utilization and Engineering Circle, Bombay State, and the Divisional Forest Officer, North Thana, Bombay State, for the supply of the wood for this investigation.

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STANDARD TERMINOLOGY FOR DESCRIBING TIMBERS

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SUMMARY

It is found that lack of recognized conventions in the use of proper adjectives for describing the properties of timbers often leads to confusion. For instance, in giving the weightiness of a timber, the adjective "heavy" has been used to denote the weight per cubic ft. of seasoned timber for various magnitudes such as 50 to 60 lbs. in one case, 39 to 49 lbs. in another, 40 to 49 lbs. in the third and 42 to 49 lbs. in the fourth case by different authors. Similarly in telling the hardness of a timber, writers use the feel they experience in cutting it by a pen-knife. This feel depends upon the sharpness of the knife, the hardness of the steel of which it is made, the moisture content of the timber and above all, the personal factor of the writer. An attempt is made in this article to standardize the meanings of various descriptive adjectives by giving them as far as possible, some definite quantitative interpretations in order to avoid the state of confusion that exists, and ensure uniformity.

Teak has been taken as the standard of comparison of all our timbers, as it is the most widely used and well-known timber, and the physical and mechanical properties of all other timbers are compared with those of teak by specially prepared comparative suitability index figures which have already been published. Indian species have been classified in this article according to their characteristics of weight, strength as a beam, hardness, shock resisting ability and retention of shape. Description of five species is given at the end as an example of the use of the proposed terminology.

INTRODUCTION

In writing descriptions of timbers, various qualifying adjectives such as light, heavy, extremely heavy, very strong, soft, hard, exceptionally hard, tough, steady and many others are used to give roughly a comparative idea of the properties of various species. For instance in describing the *weightiness* of a species, the term "heavy" is used to denote a weight of 50 to 60 lbs. per cubic ft. by one author, 39 to 49 lbs. per cubic ft. by another author, 40 to 49 lbs. per cubic ft. by a third author, and 42 to 49 lbs. per cubic ft. is also proposed. It will, therefore, be seen that there is no uniformity, and a timber which may be described as heavy by one author may be described as moderately heavy or even light by another. This lack of recognized conventions is apt to lead to confusion. In order to avoid this state of affairs and make descriptions of species more uniform, an attempt is made in this article to standardize such terms.

STANDARD OF COMPARISON

Teak has been taken as the standard for comparing the properties of all our timbers. It is a very well known and widely used timber throughout India for all sorts of work such as beams, columns, roof work, flooring, planking, panelling, doors and windows, furniture, bridges, railway coach and wagon building, motor body building, ship building and a variety of other uses. In fact it is a very good all purpose timber. Practically everybody in India is familiar with teak and its properties are well known by long usage. It is, therefore, one of the most important Indian timbers and has been chosen as a standard. It weighs about half a maund per cubic ft. and is described as heavy, strong and hard.

GROUPS ACCORDING TO WEIGHT

Considering the weights of timbers, it will at once be evident that weight is affected by the moisture contained in the timber. Therefore, for the sake of comparison, the average weight of seasoned timber in lbs. per cubic ft. at the standard moisture content of 12% is taken as an uniform standard. There are several timbers which just float in water or sink or whose average seasoned weight is over 60 lbs. per cubic ft. There are also a few timbers whose average seasoned weight is below 20 lbs. per cubic ft., i.e., below half the weight of average seasoned teak. The timbers of the first category will be called extremely heavy, i.e., those having weights of 60 lbs. per cubic ft. and above and sink in water and timbers of the second category will be called very light, i.e., below 20 lbs. per cubic ft.

It is proposed to group all the timbers into the following "light or heavy" classes according to the average weight of seasoned timber per cubic ft. at 12% moisture content, in steps of 10 lbs. each, thus :—

Class 1.	Very light	..	below 20 lbs.
2.	Light	..	20 to 29 lbs.
3.	Moderately heavy	..	30 to 39 lbs.
4.	Heavy	..	40 to 49 lbs.
5.	Very heavy	..	50 to 59 lbs.
6.	Extremely heavy	..	60 lbs. and above.

OTHER SYSTEMS OF GROUPING WEIGHTS

Some writers try to divide timbers in steps of 14 lbs. and others have suggested steps of 7 lbs. Some others are doing it in still smaller steps of 5 lbs. All these three groupings are open to objection. The first one, i.e., 14 lbs. step suggested by the Timber Development Officer in the *Indian Forester* of November, 1951, provides only four groups and classifies both spruce and teak as light timbers which it will be realized is very incorrect.

Similarly *Cryptomeria japonica* (16 lbs.) and *Abies pindrow* (28 lbs.) will both be classed as very light. 14 lbs. is also an awkward number to adopt and has no other basis except that it represents half a quarter which again is not an Indian measure. It is, therefore, clearly not a convenient grouping unit. Gamble has divided timbers in 20 lbs. steps which is still more objectionable.

The grouping in 5 lbs. steps formerly employed by the Wood Technologist and the Utilization Officer is also open to objection, as it divides timbers into too many groups and they have not provided any grouping above 50 lbs. per cubic ft. Although both these groupings are in 5 lbs. steps, they do not agree regarding the ranges.

PROPOSED CLASSIFICATION OF INDIAN TIMBERS ACCORDING TO 10 LBS. STEPS

The weight of seasoned teak is very nearly half a maund per cubic ft. which is a sufficiently heavy weight for a man to carry for any length of time. Teak is, therefore, classed as a heavy timber. The timbers falling in the various classes are given in the following list. They are arranged in the order of their weights in accordance with the proposed *standard* classification given above. The weights shown against each species *are* generally average weights of a large number of specimens from 5 trees from one locality and are thus reliable. The average weight of species may change by one or two lbs. for other localities but will not materially affect the classification except probably in a few border cases of the various classes.

CLASSIFICATION OF TIMBER SPECIES ARRANGED ACCORDING TO THEIR WIEGHTS

Species	Weight per cu. ft. of seasoned timber at 12% moisture content	Species	Weight per cu. ft. of seasoned timber at 12% moisture content
Very light timbers			
Weight below 20 lbs. per cu. ft.			
Ochroma spp.	13	*Erythrina* spp.	19
Cryptomeria japonica ..	16		
Light timbers			
Weight 20 to 29 lbs. per cu. ft.			
Sterculia campanulata ..	20	*Canarium euphyllum* ..	26
Alnus nepalensis	23	*Abies pindrow*	28
Bombax spp.	23	*Populus ciliata*	28
Ailanthus grandis	25	*Elæocarpus tuberculatus* ..	29
Tsuga brunoniana	25	*Lophopetalum wightianum* ..	29
Alstonia scholaris	26		
Moderately heavy timbers			
Weight 30 to 39 lbs. per cu. ft.			
Anthocephalus cadamba ..	30	*Juglans* spp.	36
Cedrela toona	30	*Pinus longifolia*	36
Duabanga sonneratioides ..	30	*Vateria indica*	36
Parishia insignis	30	*Anisoptera glabra*	37
Picea morinda	30	*Artocarpus hirsuta*	37
Buchanania latifolia ..	31	*Artocarpus integrifolia* ..	37
Gmelina arborea	31	*Cinnamomum iners*	37
Holarrhena antidysenterica ..	31	*Holoptelea integrifolia* ..	37
Hymenodictyon excelsum ..	31	*Melia azedarach*	37
Manglietia insignis	31	*Polyalthia fragrans*	37
Michelia spp.	31	*Sterculia alata*	37
Salix spp.	31	*Dichopsis elliptica*	38
Artocarpus chaplasha ..	32	*Hardwickia pinnata* ..	38
Cupressus torulosa	32	*Heterophragma roxburghii* ..	38
Machilus macrantha ..	32	*Pterospermum acerifolium* ..	38
Myristica attenuata	32	*Terminalia myriocarpa* ..	38
Pinus excelsa	32	*Acer* spp.	39
Ulmus wallichiana	32	*Amoora wallichii*	39
Boswellia serrata	34	*Bucklandia populnea* ..	39
Phœbe spp.	34	*Castanopsis hystrix*	39
Podocarpus spp.	34	*Cullenia excelsa*	39
Shorea assamica	34	*Dillenia pentagyna*	39
Cedrela serrata	35	*Lagerstrœmia hypoleuca* ..	39
Cedrus deodara	35	*Pinus insignis*	39
Lannea grandis	35	*Sagerœa laurina*	39
Bridelia retusa	36	*Sonneratia apetala*	39
Engelhardtia spicata ..	36	*Terminalia procera*	39
Garuga pinnata	36		

Species	Weight per cu. ft. of seasoned timber at 12% moisture content	Species	Weight per cu. ft. of seasoned timber at 12% moisture content
	Heavy timbers *Weight 40 to 49 lbs. per cu. ft.*		
Albizzia lebbek	40	*Dipterocarpus macrocarpus* ..	45
Albizzia procera	40	*Fraxinus* spp.	45
Calophyllum spp.	40	*Parashorea stellata*	45
Dillenia indica	40	*Pterocarpus dalbergioides* ..	45
Lagerstrœmia flos-reginæ ..	40	*Stereospermum suaveolens* ..	45
Pentace burmanica	40	*Acacia leucophlœa*	46
Swietenia floribunda ..	40	*Albizzia odoratissima* ..	46
Tectona grandis (C.I. region) ..	40	*Dysoxylum malabaricum* ..	46
Canarium bengalense ..	41	*Lagerstrœmia parviflora* ..	46
Canarium strictum	41	*Saccopetalum tomentosum* ..	46
Chuckrasia tabularis ..	41	*Stereospermum chelonoides* ..	46
Lagerstrœmia tomentosa ..	41	*Terminalia pyrifolia* ..	46
Mallotus philippinensis ..	41	*Carallia lucida*	47
Mangifera indica	41	*Dipterocarpus* spp.	47
Mitragyna diversifolia ..	41	*Gluta travancorica*	47
Mitragyna parvifolia ..	41	*Grewia vestita*	47
Morus serrata	41	*Hopea odorata*	47
Adina cordifolia	42	*Miliusa velutina*	47
Lagerstrœmia lanceolata ..	42	*Pongamia glabra*	47
Tectona grandis (Burma & S.I.)	42	*Bischofia javanica*	48
Acrocarpus fraxinifolius ..	43	*Casuarina equisetifolia* ..	48
Cinnamomum inunctum ..	43	*Eugenia jambolana*	48
Machilus odoratissima ..	43	*Gardenia turgida*	48
Schima wallichii	43	*Prosopis spicigera*	48
Stereospermum xylocarpum ..	43	*Thespesia populnea*	48
Terminalia bialata	43	*Bassia butyracea*	49
Amoora rohituka	44	*Carapa moluccensis*	49
Dipterocarpus bourdilloni ..	44	*Dalbergia sissoo*	49
Gardenia latifolia	44	*Grewia tiliæfolia*	49
Morus alba	44	*Qugeinia dalbergioides* ..	49
Zanthoxylum rhetsa	44	*Terminalia paniculata* ..	49
Dichopsis polyantha ..	45		
	Very heavy timbers *Weight 50 to 59 lbs. per cu. ft.*		
Altingia excelsa	50	*Kayea floribunda*	51
Pterocarpus marsupium ..	50	*Acacia arabica*	52
Terminalia arjuna	50	*Melia indica*	52
Terminalia belerica	50	*Sageræa listeri*	52
Aglaia edulis	51	*Terminalia manii*	52
Dalbergia latifolia	51	*Xylia xylocarpa*	52
Diospyros melanoxylon ..	51	*Anogeissus acuminata* ..	53

(*contd.*)

Species	Weight per cu. ft. of seasoned timber at 12% moisture content	Species	Weight per cu. ft. of seasoned timber at 12% moisture content
Very heavy timbers *Weight 50 to 59 lbs. per cu. ft.*—(contd.)			
Diospyros pyrrhocarpa ..	53	*Pistacia integerrima* ..	55
Dipterocarpus tuberculatus ..	53	*Aegle marmelos*	56
Eucalyptus eugenioides ..	53	*Cynometra polyandra* ..	56
Hardwickia binata	53	*Pentacme suavis*	57
Heterophragma adenophyllum ..	53	*Planchonia andamanica* ..	57
Melanorrhœa usitata ..	53	*Terminalia chebula*	57
Terminalia tomentosa ..	53	*Xylia dolabriformis* ..	57
Anogeissus sericea	54	*Anogeissus latifolia*	58
Cassia fistula	54	*Anogeissus pendula* ..	58
Pentace griffithii	54	*Bassia latifolia*	58
Pterocarpus macrocarpus ..	54	*Dalbergia cultrata*	58
Quercus spp.	54	*Homalium tomentosum* ..	58
Shorea robusta	54	*Hopea parviflora*	58
Careya arborea	55	*Vitex altissima*	58
Mimusops elengi	55	*Eugenia gardneri*	59
Extremely heavy timbers *Weight 60 lbs. per cu. ft. and above*			
Berrya ammonilla	60	*Shorea obtusa*	65
Chloroxylon swietenia ..	60	*Hopea glabra*	67
Mesua ferrea	60	*Acacia chundra*	68
Acacia catechu	61	*Schleichera trijuga*	68
Acacia ferruginea	61	*Mimusops littoralis*	69
Balanocarpus utilis	62	*Pterocarpus santalinus* ..	70
Heritiera minor	65	*Soymida febrifuga*	70
Millettia pendula	65	*Pœciloneuron indicum* ..	71

OTHER QUALITIES

Other important qualities required to be described are related to the mechanical properties of timbers such as strength, hardness, toughness, etc. In these cases, characteristic descriptive adjectives are determined from the comparative suitability index figures for each species prepared and published by the Timber Mechanics Branch from the results of strength tests.

STRENGTH

For describing strength of a timber, comparative index figures for suitability as a beam are used. If the strength as a beam of teak timber is taken as 100, the figures for other species range from 25 to 150. A timber having a figure of less than 50, i.e., less than half the strength of teak is taken as a very weak timber. The other groups are given below :—

Strength classification of species according to the index figure for strength as a beam

1. Very weak .. below 50
2. Weak .. 50 to 69
3. Moderately strong .. 70 to 89
4. Strong .. 90 to 109
5. Very strong .. 110 to 129
6. Extremely strong .. 130 and above.

CLASSIFICATION OF TIMBER SPECIES ARRANGED ACCORDING TO THE INDEX FIGURES FOR STRENGTH AS A BEAM

Species	Strength as a beam	Species	Strength as a beam
	Very weak timbers		
	Strength as a beam below 50		
Cryptomeria japonica ..	24	*Alnus nepalensis*	47
Bombax spp.	43	*Tsuga brunoniana*	47
Sterculia campanulata ..	43	*Alstonia scholaris*	48
Ulmus wallichiana	45		
	Weak timbers		
	Strength as a beam 50 to 69		
Canarium euphyllum ..	50	*Gmelina arborea*	60
Hymenodictyon excelsum ..	51	*Picea morinda*	60
Parishia insignis	51	*Holarrhena antidysenterica* ..	61
Buchanania latifolia ..	52	*Pinus longifolia*	61
Gardenia turgida	52	*Duabanga sonneratioides* ..	62
Lophopetalum wightianum ..	52	*Elæocarpus tuberculatus* ..	62
Populus ciliata	52	*Machilus macrantha* ..	62
Salix spp.	52	*Anthocephalus cadamba* ..	65
Ailanthus grandis	53	*Michelia* spp.	65
Engelhardtia spicata ..	53	*Shorea assamica*	65
Pinus excelsa	53	*Acer* spp.	66
Myristica attenuata.. ..	55	*Holoptelea integrifolia* ..	67
Boswellia serrata	56	*Garuga pinnata*	68
Cedrela toona	57	*Cupressus torulosa*	69
Lannea grandis	57	*Morus serrata*	69
Abies pindrow	60		
	Moderately strong timbers		
	Strength as a beam 70 to 89		
Anisoptera glabra	70	*Artocarpus integrifolia* ..	75
Bischofia javanica	70	*Mangifera indica*	75
Mallotus philippinensis ..	70	*Swietenia floribunda* ..	75
Miliusa velutina	70	*Terminalia arjuna*	75
Manglietia insignis.. ..	71	*Terminalia procera*	75
Phœbe spp.	71	*Vateria indica*	75
Pinus insignis	71	*Hardwickia binata*	76
Bridelia retusa	72	*Juglans* spp.	76
Melanorrhea usitata ..	72	*Melia azedarach*	76
Sonneratia apetala	72	*Bassia latifolia*	77
Diospyros melanoxylon ..	73	*Cedrela serrata*	77
Mitragyna parvifolia ..	73	*Cinnamomum inunctum* ..	77
Podocarpus spp.	73	*Aegle marmelos*	78
Castanopsis hystrix	74	*Artocarpus chaplasha* ..	78
Heterophragma roxburghii ..	74	*Dillenia pentagyna*	78
Terminalia myriocarpa ..	74	*Lagerstrœmia flos-reginæ* ..	78

(*contd.*)

Species	Strength as a beam	Species	Strength as a beam
Moderately strong timbers *Strength as a beam 70 to 89*			
Lagerstrœmia hypoleuca	78	*Cinnamomum iners*	83
Ougeinia dalbergioides	78	*Pterospermum acerifolium*	83
Polyalthia fragrans	78	*Stereospermum suaveolens*	83
Pongamia glabra	78	*Albizzia lebbek*	84
Cedrus deodara	79	*Gardenia latifolia*	84
Schima wallichii	79	*Acacia leucophlœa*	85
Stereospermum xylocarpum	79	*Albizzia procera*	85
Machilus odoratissima	80	*Calophyllum* spp.	85
Pistacia integerrima	80	*Casuarina equisetifolia*	85
Amoora wallichii	81	*Melia indica*	85
Dillenia indica	81	*Tectonag randis* (C.I. Region)	85
Lagerstrœmia lanceolata	81	*Dipterocarpus bourdilloni*	86
Morus alba	81	*Sagerœa laurina*	86
Adina cordifolia	82	*Sterculia alata*	86
Careya arborea	82	*Dysoxylum malabaricum*	87
Chukrasia tabularis	82	*Amoora rohituka*	88
Hardwickia pinnata	82	*Dalbergia sissoo*	88
Bucklandia populnea	83	*Lagerstrœmia parviflora*	88
Canarium strictum	83	*Lagerstrœmia tomentosa*	88
Strong timbers *Strength as a beam 90 to 109*			
Dipterocarpus alatus	90	*Terminalia tomentosa*	97
Eugenia jambolana	90	*Acrocarpus fraxinifolius*	98
Saccopetalum tomentosum	90	*Grewia vestita*	98
Dichopsis elliptica	91	*Zanthoxylum rhetsa*	98
Diospyros pyrrhocarpa	91	*Anogeissus pendula*	99
Terminalia bialata	91	*Prosopis spicigera*	99
Artocarpus hirsuta	92	*Terminalia paniculata*	99
Canarium bengalense	92	*Anogeissus latifolia*	100
Parashorea stellata	92	*Dipterocarpus macrocarpus*	100
Terminalia paniculata	92	*Dipterocarpus* spp.	100
Dalbergia latifolia	93	*Pterocarpus dalbergioides*	100
Eugenia gardneri	93	*Tectona grandis* (Burma & S.I.)	100
Pentace burmanica	93	*Terminalia belerica*	100
Terminalia pyrifolia	93	*Altingia excelsa*	101
Bassia butyracea	94	*Hopea odorata*	101
Cullenia excelsa	94	*Terminalia chebula*	101
Gluta travancorica	94	*Planchonia andamanica*	102
Carapa moluccensis	95	*Xylia xylocarpa*	102
Fraxinus spp.	95	*Kayea floribunda*	103
Dichopsis polyantha	96	*Pterocarpus marsupium*	103
Stereospermum chelonoides	96	*Quercus* spp.	104
Terminalia manii	96	*Acacia arabica*	105

(*contd.*)

Species	Strength as a beam	Species	Strength as a beam
Strong timbers			
Strength as a beam 90 to 109—(contd.)			
Dabergia cultrata	106	*Homalium tomentosum* ..	107
Mimusops elengi	106	*Chloroxylon swietenia* ..	108
Anogeissus sericea	107	*Eucalyptus eugenioides* ..	109
Aglaia edulis	107	*Heritiera minor*	109
Heterophragma adenophyllum ..	107		
Very strong timbers			
Strength as a beam 110 to 129			
Vitex altissima	110	*Dipterocarpus tuberculatus* ..	116
Berrya ammonilla	112	*Shorea robusta*	117
Anogeissus acuminata ..	113	*Thespesia populnea*	121
Carallia lucida	113	*Hopea parviflora*	122
Cynometra polyandra ..	113	*Millettia pendula*	124
Pentacme suavis	114	*Acacia catechu*	125
Cassia fistula	115	*Xylia dolabriformis*	126
Albizzia odoratissima ..	116	*Hopea glabra*	127
Extremely strong timbers			
Strength as a beam 130 and above			
Pentace griffithii	131	*Soymida febrifuga*	138
Sagerœa listeri	133	*Acacia ferruginea*	139
Pterocarpus santalinus ..	134	*Mimusops littoralis*	142
Shorea robusta	136	*Balanocarpus utilis*	145
Pterocarpus macrocarpus ..	137	*Mesua ferrea*	147
Schleichera trijuga	137	*Acacia chundra*	152
Pœciloneuron indicum ..	138		

HARDNESS

For describing hardness of a timber, the comparative index figure for hardness is used. If the hardness figure for teak is taken as 100, the figures for other species range from 20 to 285. A timber having a hardness figure of less than 50, i.e., less than half the hardness of teak, is called a very soft timber. The other groups are given below :—

1. Very soft .. below 50
2. Soft .. 50 to 69
3. Moderately hard .. 70 to 89
4. Hard .. 90 to 119
5. Very hard .. 120 to 149
6. Extremely hard .. 150 to 199
7. Exceptionally hard .. 200 and above.

As the range of hardness is great a seventh class of exceptionally hard timbers has been introduced in this case.

TOUGHNESS

Toughness is the quality of resisting shocks and is useful in describing the property required in timbers for making hammer handles, helves, camp furniture, sports goods and such other articles. There are only a very limited number of tough timbers. Teak is not considered a tough timber. The classification for toughness is based on the index figures for shock resisting ability.

Toughness classification of species according to index figures for shock resisting ability
(Taking teak as 100)

1.	Moderately tough	..	100 to 119
2.	Tough	..	120 to 139
3.	Very tough	..	140 to 179
4.	Extremely tough	..	180 and above.

STEADINESS

Steadiness is the property of retaining the shape of manufactured articles such as furniture, panels, door and window frames, decking, etc., without too much distortion and working. Teak is the most steady timber so far found. This property is based on index figures for retention of shape.

Steadiness classification of species according to index figures for retention of shape
(Taking teak as 100)

1.	Liable to warp and crack	..	..	50 to 59
2.	Liable to hair splitting and cracking		..	60 to 69
3.	Moderately steady	..	..	70 to 79
4.	Steady	..	..	80 to 89
5.	Very steady	..	..	90 to 100 and above.

GRAIN

There is another property namely the grain of timber which is also of importance. Timbers are stated as having straight grain, interlocked grain, heavily interlocked ribbon pattern grain and so on. This property has so long been described only from ones' own experience. We have been studying this property for a long time and hope to put it soon on some definite basis with rough quantitative values for guidance by measuring the degree of interlocking of the various species.

DESCRIPTION OF SPECIES USING THE TERMINOLOGY GIVEN ABOVE

Five species are described below as an example of using this terminology. The figures given in brackets show the numerical value for the terms used. It is not intended to give these values in usual descriptions. They are given here only as an illustration.

Axle wood – *Anogeissue latifolia*—Axle wood is a very heavy (58), strong (100), extremely hard (165), very tough (170), straight grained timber. It is liable to fine hair splitting and cracking (65).

Mesua, Nahor – *Mesua ferrea*—*Nahor* is an extremely heavy (60), extremely strong (145), exceptionally hard (215), and very tough (160) timber. It is liable to warp and crack (55). It is generally interlocked. But straight grained trees are often met with.

Rosewood – *Dalbergia latifolia*—Rosewood is a very heavy (51), strong (95), extremely hard (165), tough (135), and steady (80) timber. It is slightly interlocked.

Teak – *Tectona grandis*—Teak is a heavy (43), strong (100), hard (100), moderately tough (100), and very steady (100) straight grained timber.

Deodar – *Cedrus deodara*—*Deodar* is a moderately heavy (35), moderately strong (80), moderately hard (70), steady (85) and straight grained timber.

CONCLUSION

The terminology proposed above is based on definite quantitative values of the various properties and will make writing down descriptions of species simple and uniform. This terminology is recommended as a standard for future use in all Forest Research Institute publications in order to avoid confusion.

STATISTICAL METHODS IN FOREST PRODUCTS RESEARCH*

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SUMMARY

Statistical methods can help in (1) sampling of test material (2) experimental design and (3) interpretation of results. The paper cites examples of the application of statistical methods in experimental design and analysis of data in research conducted in the Forest Products Laboratories at Madison, Princes Risborough, Melbourne and Dehra Dun.

It has been found that to obtain greater precision for species averages of strength properties of timber, at a given cost, the test material should come from as large a number of trees as possible with consequent reduction in the number of specimens from each tree.

The range is almost as good a measure of variation as the standard deviation in samples of 6 or less number of observations. Its use is therefore recommended for these sizes of samples and the method of indirectly estimating the standard deviation from the range is explained.

Finally, the paper recommends the use, wherever possible, of factorial designs, confounding, fractional replications, incomplete blocks, etc., in designing experiments on laboratory and pilot plant scale.

INTRODUCTION

The earliest published account, that has come to the author's notice, of the use of statistical methods in Forest Products Research is the paper by J. D. Maclean "Percentage Renewals and Average Life of Railway Ties" in *Engineering News Record* of August 26, 1926. The nomogram prepared by him in that paper has become universally known as the 'Madison curve' for forecasting the expected life of railway sleepers and is extensively used in India. The Madison Laboratory was also the pioneer in using statistical methods of regression analysis for determining the relationship between various physical and mechanical properties of wood.

As regards Forest Products Laboratories in the Commonwealth, the earliest publication known to the author is a paper entitled "Examples of statistical methods in Forest Products Research" by E. D. Van Rest, Statistician of the Forest Products Laboratory, Princes Risborough, England in the *Supplement to the Journal of the Royal Statistical Society*, Vol. IV, 1937, pp. 184–203. The Forest Products Laboratory at Melbourne in Australia has been maintaining a Section of Mathematical Statistics for the last fifteen years. The various progress reports of research issued from that Laboratory bear the stamp of the high statistical standards attained in experimental design and analysis of experimental data by the research workers of that Laboratory. Mr. E. J. Williams, Head of the Section of Mathematical Statistics of the Laboratory at Melbourne has given a large number of examples of the use of statistical methods both in the planning and carrying out of experiments, and in the interpretation of the results in his "*Lectures in Experimental Design and Analysis*" published in 1949.

In India, the Forest Research Institute at Dehra Dun which conducts research in forest products as well as in forestry, a Statistical Branch was created in 1947 with a technical staff

* Paper presented to the Sixth British Commonwealth Forestry Conference, Ottawa, Canada, August–September, 1952.

consisting of one Statistician, one Assistant Statistician, two Head Computors, and six Computors. The work of the Branch may be broadly classified as follows :—

(i) The statistical design of experiments in forest products as well as forestry research.

(ii) The statistical analysis and interpretation of the results of these experiments.

(iii) Critical statistical analysis and interpretation of existing experimental data.

(iv) Research on statistical theory of experimental design and analysis.

(v) Research on sampling techniques.

Sampling

Sampling is an essential procedure in testing strength properties of various species of wood. The common standard followed in all Forest Product Laboratories is to select only five trees from each commercially important locality where the species is grown. A large number of small clear specimens is tested for each tree. Recent statistical analysis of data accumulated in F.P.L. of Australia as well as in F.R.I., India show that variation between trees has a greater influence than variation within trees in determining the precision of the species mean. It is, therefore, important to increase the number of trees. The number of specimens from each tree could be very much reduced.

Classification of Timber

On the basis of species means of the various strength properties, some countries classify their timber species into a number of groups labelled 'Very strong', 'Strong', 'Moderately strong', etc. This classification is a very difficult problem especially as a large number of properties has to be taken into account and the species means are subject to sampling fluctuations. Statistical methods of multivariate analysis and discriminant functions can offer an objective and valid solution for this problem.

Presentation of Data

The Timber Mechanics Conference held at Ottawa and Madison in 1948 as a result of the recommendation of the Fifth British Empire Forestry Conference held in Great Britain in 1947 have laid stress on statistical analysis and framed rules for presentation of test results. (See Resolution No. 13).

The same points were emphasized in one of the resolutions of the First Conference on Mechanical Wood Technology held by the F.A.O. at Geneva during August–September, 1949 which reads as follows :—

> "The Conference recognizes the desirability of employing statistical methods, whereever possible, for the interpretation of test data. It is suggested that the minimum desirable information to be presented should be the number of observations, the mean and the standard deviation. The standard deviation should be quoted to three significant figures and the mean value to the same number of decimal places. Where it is desired to investigate relationships between properties, regression and correlation techniques should be employed".

For samples of six or less number of observations the range (difference between the maximum and minimum observed value) is almost as good a measure of variation as the standard deviation. In such cases it is enough to present, besides the number of observations and the mean, the maximum and minimum values.

There is one important point to be borne in mind while using the range as a measure of variation. Unlike the standard deviation its magnitude depends very much on the number of observations. Thus the range for a sample say of 4 will on the average be less than the range for a sample of say 6. Hence when the results presented are for tests with unequal numbers of observations, the values of the range are not directly comparable. What is done in such cases is to indirectly estimate the standard deviation from the range using a formula worked out by Tippett in *Biometrika*, Vol. 17, pp. 386–7. This formula is of the form

$$\text{Standard Deviation} = \frac{1}{d_n} \times \text{Range.}$$

Values of d_n and $\frac{1}{d_n}$ when the samples are drawn from a Normal population are given below for sample sizes $n = 2$ to 6.

n	d_n	$\frac{1}{d_n}$
2	1·128	·8862
3	1·693	·5908
4	2·059	·4857
5	2·326	·4299
6	2·534	·3946

Because of the extreme simplicity in its calculation, the range is preferred to the standard deviation in drawing statistical quality control charts of manufactured products. Wood-based industries like plywood, fibre board, paper, etc., have begun to make use of these charts in improving the quality of their products.

EXPERIMENTAL DESIGN

Simple experimental designs such as randomized blocks and Latin squares are of direct application in laying out experiments where different wood preservatives are compared by treating with them poles, posts, stakes, etc., and leaving the latter on the ground for exposure to attack by termite, fungus and insects. These experiments come very close to silvicultural and agricultural field experiments as regards the field lay-out.

There is great scope for use of factorial designs in forest products research. For instance, be it in the manufacture of a glue adhesive, plywood or paper the optimum conditions for manufacturing the product can be arrived at only by a simultaneous study of a number of factors which could be varied at will to some extent. In a recent experiment on the delignification of sabai grass, the Cellulose and Paper Branch of this Institute used a factorial design. There were four factors under study, namely, (a) time of reaction, (b) total alkali on raw material, (c) concentration of alkali solution, and (d) temperature of reaction. The following four variants of each factor were used in all combinations so that there were 256 treatments in this experiment.

(*a*) *time of reaction*
1, 2, 3 and 4 hours

(*b*) *total alkali on raw material*
12, 15, 18 and 21 per cent of air-dry grass

(*c*) *concentration of alkali*
2, 2·5, 3 and 3·5 per cent

(*d*) *temperature*
138, 143, 148 and 153°C.

When factorial designs of this type come into common use in forest products research, the device of confounding, fractional replication, etc., could be applied to further improve the precision of experimental results and also in reducing the out-lay in time and money for conducting the experiments. As example of an experiment involving fractional replication, it may be pointed out that in the delignification experiment adverted to above, it is possible to reduce the number of treatments from 256 to say 64 without reducing the number of factors or the number of variants of each factor and also without sacrificing much information on the main effects of these factors and their two-factor interactions. This will then be a factorial experiment with one-fourth replicate. The chosen set of 64 treatments should, however, be replicated at least twice so that an estimate of experimental error could be obtained from the data and the precision of the main effects evaluated. The method of choosing the 64 treatments involves statistical theory and has to be left to the statistician.

In experiments where the treatments involve only a single factor, recent developments in experimental design such as incomplete blocks, quasi-Latin squares, Youden squares, etc., have wide scope of application in forest products research. The papers by Van Rest and by Williams give examples of actual application in the Forest Products Laboratory at Princes Risborough and at Melbourne respectively. A beginning has been made in Dehra Dun to use these improved designs. An experiment to investigate comparative efficacy of 13 preservative treatments against insect attack of felled bamboo was laid out for the Entomology Branch using a Youden square design. Each bamboo culm could *give only 4 pieces and so only 4 treatments out of the 13* could be compared on the same culm. By the Youden square method it was possible to overcome this difficulty and to obtain comparisons between treatments which were free from variations between culms and also from any systematic variation that might have existed within a culm from top to bottom. Again, where logs or scantlings treated with different preservatives have to be stacked in layers to economize space during exposure to insect attack, the latin-cube design becomes quite useful.

An excellent treatise of the subject will be found in Cochran and Cox's "Experimental Designs", John Wiley & Sons, 1950.

Several articles illustrating how the principles of statistics can be utilized by chemists and chemical engineers to obtain more precise results from their experimental work have been appearing in recent years on the pages of *Analytical Chemistry* and the *Industrial and Engineering Chemistry*. A bibliography of literature on statistical applications will be found at the end of a paper "Statistics applied to analysis" by G. Wernimont in *Analytical Chemistry* of January, 1949, p. 115. To quote from his paper :—

> The importance of the design of an experiment becomes very apparent when statistical methods are used to help analyse the results. If an experiment is not correctly designed, it will often be impossible to give a rigorous answer to the question that gave rise to the experiment. Illustrations of this state of affairs can be found in almost any issue of *Analytical Chemistry.*

Also, to quote from an article by W. L. Gore, in *Industrial Engineering Chemistry* of February, 1950, p. 320 :—

> An axiom is prevalent among chemists that controlled experiments consists in holding all variables constant except the one under study and determining its independent effect'. Unfortunately, in chemical mechanisms the effect of variables often is not independent and a simple interpretation of this maxim leads to confusing and anomalous results from experimental work. A branch of statistical methods known as design of experiments is being developed which has great potential value for chemists engaged in experimental work. A clear understanding of the rigorous requirements of experimental arrangements to give specified information is a worth-while educational goal for any chemist.

Recently a book has been published by W. J. Youden entitled "Statistical Methods for Chemists" (John Wiley & Sons) where he combines the modern concept of experimental design with the associated techniques for the interpretation of data.

In conclusion, suffice to say that statistically planned experiments offer greater precision and economy in every field of research.

WOOD PRESERVATION IN INDIA

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(*Continued from page 65, Vol. 79, No. 1*)

FIRE PROTECTION OF TIMBER

Apart from deterioration from biological causes as mentioned earlier, timber is also susceptible to serious damage from fire. This is because it consists mainly of cellulose and cellulose is combustible. Tests on the natural durability of timber with reference to fire indicates that while primarily all timbers do catch fire when exposed to high temperatures, the amount of deterioration in individual species varies to some extent, depending on the interrelated properties like structure, density and porosity, and also on the infiltrated chemical substances. It is no doubt true that wood should be dry before it catches fire ; decayed wood can be ignited more easily than sound wood. At about 200°C. considerable time is required to kindle even dry timber. At 275°C. timber slowly gets charred and then finally ignites. At 400°C. the ignition takes place quite quickly. Generally, a temperature of over 1,000°C. is reached in fires. At this temperature the small variations in the natural resistance of timbers matters little, and all structural timbers behave almost in the same way. Under these circumstances, it is the type of construction and the cross-section of the timber members of a structure that are the controlling factors and not the species of timber used. Heavy timber construction known as "mill construction" is regarded as a safe type for a building against fire. As regards size of the timber members, any cross-section over 6 $\times$ 6 inches is said to withstand fire better than steel. Iron and steel get easily and quickly twisted and crushed under load when exposed to fire temperatures. On the other hand, wooden beams and columns when used in large cross-sections soon develop a charred shell which retards combustion and thus enables timber to retain its strength for a fairly long period. In fact, in the initial stages of fire, timber actually increases in strength in a small measure because its moisture content is reduced due to heat, and any loss in strength suffered by timber due to carbonization is more than compensated for by this increase in strength due to loss of moisture. This is not so with iron which continuously loses strength as the temperature and period of exposure to fire are increased. Iron has a very high coefficient of thermal expansion. Therefore, an iron girder quickly throws off the walls on which it rests when a building is on fire. This leaves very little time for the occupants of a house to rush out and save themselves. In its low coefficient of thermal expansion, particularly along the grain, a wooden beam rarely causes collapse of the walls in a burning building. In all fires of residential houses and factories, it is not the loss of property that is so important as that of human life. In this sense a timber building decidedly offers greater protection than a metal-structure. This is particularly so when the building is, several stories high. It is therefore, advisable that timber is used in place of iron in all structures like residential buildings, factories, bridges, ships, aeroplanes, etc. The natural resistance of these timber structures against fire can considerably be increased by adopting suitable chemical treatment.

The chemicals that are generally used in the protection of timbers against fire can be grouped under three categories : (1) those that are highly hygroscopic like zinc chloride, sodium chloride, etc. – these chemicals retard fire because they give off water vapour when exposed to fire and thus act as automatic extinguishers of fire ; (2) those that give off, due to

decomposition when exposed to fire, gases like carbon dioxide, ammonia, nitrogen, etc., which do not support fire. Examples of such substances are ammonium nitrate, calcium carbonate, sodium bicarbonate, etc., and (3) those that crystallize in wood and in some cases swell up in wood on exposure to fire. These plug in the pores in the timber and thus keep out to that extent, air containing oxygen which supports the fire, sodium tetraborate, boric acid, borax, magnesium phosphate, ammonium phosphate (monobasic) are examples of the chemicals that act in this way. While all these chemicals can be used for protection of timbers against fire, their scope is limited to internal structures only, because these salts are water soluble and are leached out by rain in outside locations. To retard leaching, sodium dichromate is generally used as in fixed type of water soluble preservative. Since large quantities of chemicals are required to make any effective contribution to resist fire, these chemicals are impregnated at the rate of 3–10 lbs. dry salt per cubic foot depending on the species of timber, its sapwood content, and the degree of fire protection required. If in addition protection is required against deterioration of timber from biological causes, this is easily achieved by adding to the fire protective composition suitable wood preservatives of the water soluble type. However, to economize the cost of treatment, the timber may be given a two stage treatment : the first with a low concentration of the chemicals so as to ensure low absorption of the preservative, this is because for normal wood preservation purposes about 1 lb. of dry preservative chemicals will suffice ; and the second treatment may be with increased concentration so that a thick and highly concentrated layer of the fire-proofing composition is deposited in the peripheral sections. After all, it is the surface of timber that has to withstand the first onslaught of fire. Such a fire-proof-cum-antiseptic composition has been developed recently at the Forest Research Institute. This has given satisfactory results not only with timber, but also with thatch grasses, palmyra leaves, and also textile fabrics. The first experiments on a commercial scale were satisfactorily completed by treating 600 sleepers on behalf of the Central Standards Office, Ministry of Railways, *vide* plate No. 8. As regards the method of treatment, both the pressure and non-pressure processes can be employed as for wood preservation, depending upon the absorptions required and the ease with which the timber or grasses can be impregnated.

In some cases where such a high and deep penetration as is afforded by the above mentioned treatments is not necessary, surface coatings with suitable paints can be given and repeated once in every 2–3 years since some of these chemicals age, "they tend to loose their property of intumescence and with it their effectiveness"[4d]. Some of the chemicals used for this purpose consist of sodium silicate, phosphoric acid, ammonium phosphate, etc. For inside use binders like starch, gum arabic, casein, tamarind seed powder, etc., can be used. For external use costly synthetic resins, bituminous tar products, may be used as binders. For plastering on mine props in situ, lime or cement can also be used. A suitable composition has been evolved recently at the Forest Research Institute, Dehra Dun, using some of our waste mineral products at the mines. Use of this composition, incidentally, will increase Governments' revenue from royalties.

Some of the fire-proofing compositions[24a and b] are given below :—

For impregnation :

Inside use : (*a*) Zinc chloride, (*b*) Ammonium phosphate (monobasic), (*c*) Ammonium borate. Outside use : (*a*) Zinc chloride 54 parts and ammonium phosphate (monobasic) 46 parts, (*b*) Chromated zinc chloride, (*c*) Magnesium arsenate, (*d*) Magnesium pyrophosphate, (*e*) Fire-proof-cum-antiseptic composition recently evolved at the Forest Research Institute, Dehra Dun[18] :—

Fire-proof-cum-antiseptic composition developed at the Forest Research Institute, Dehra Dun

Boric acid .. 3 parts by weight

Copper sulphate	.. 1	part by weight
Zinc chloride	.. 5	Do.
Sodium dichromate	.. 6–7	Do.

Paints

(*a*)	Barytes ..	.. 1·2	parts	Sodium silicate 0·75	
	Asbestos ..	.. 0·6	part in medium	Soft soap 0·36	
	Borax ..	.. 0·12	part		
	Ammonium phosphate	.. 0·6	part		
(*b*)	Water glass ..	.. 27	parts by weight		
	Talcum powder	.. 48	Do.		
	Water ..	.. 25	Do.		
(*c*)	White lead ..	.. 41	parts by weight		
	Borax ..	.. 32	Do.		
	Turpentine ..	.. 3·6	Do.		
	Japan drier ..	.. 0·6	Do.		
(*d*)	Ammonium sulphate	.. 28	parts by weight		
	Ammonium carbonate	.. 14	Do.		
	Borax ..	.. 7	Do.		
	Boric acid ..	.. 7	Do.		
	Alum ..	.. 14	Do.		
	Water ..	.. 500	Do.		
(*e*)	Ashes[18] ..	.. 25	parts by weight	Recently developed paint at the Forest Research Institute, Dehra Dun. (For plastering, lime or cement can be used ; for outside use synthetic resins, bitumen coal tar, etc., can be used as binder).	
	Mica powder ..	.. 25	Do.		
	Borax ..	.. 15	Do.		
	Asbestos powder	.. 10	Do.		
	Zinc oxide ..	.. 10	Do.		
	Tamarind seed powder	.. 10	Do.		
	Gum arabic ..	.. 5	Do.		

PRESERVATIVES AND THEIR PROPERTIES

The chief characteristics of an ideal wood preservative are :—

(1) high toxicity (high lethal effect even in low concentration) against fungi and/or insects and/or marine organisms ;

(2) high permanency under all service conditions, i.e., resistance to leaching by water or to rapid evaporation due to heat, or chemical transformation due to oxidation, reduction, polymerization or chemical or enzymic action causing reduction in toxicity ;

(3) high penetrability, i.e., amenability to impregnation over the entire cross section of the wood to be treated ;

(4) high stability during treatment, i.e., resistance to decomposition at temperatures normally used during treatment and precipitation due to reducing action of chemicals in timber.

Further the preservative—

(1) should not increase unduly the inflammability of wood but in fact should aim at increasing the natural resistance of timber to fire – data on the inflammability of various preservatives when impregnated in timber for normal wood preservation purposes is given[26] in Table 15 ;

(2) should not impair the health of the labour during treatment or the workmen during assembly of treated timber or the residents of a house either, while in occupation, or in a fire accident when treated timber is used in the construction ;

(3) should be economic and easily available if not produced from indigenous sources ;

(4) should be capable of being transported to distant places and great heights without excessive charges ;

(5) should not corrode metals used in the manufacture of treating equipment or metals used along with treated timber during actual service ;

and (6) should allow treated timber to be painted over or varnished.

It is not always possible to obtain such an ideal preservative, but care is necessary before a compromise is made and a suitable preservative is chosen for any particular use, the deciding factor being proven service efficiency.

There are a large variety of preservatives available for wood preservation purposes. These fall under three types :

(*a*) Oil type, (*b*) Water soluble type and (*c*) Organic solvent type. A brief description of the preservatives is given below along with details on their cost and availability.

(*a*) *Oil type – Creosotes*—There are many types of creosotes used for wood preservation purposes such as coal-tar-creosote, wood-tar-creosote, and water-gas-tar-creosote. But, by far the best and widely used creosote of established reputation is the coal-tar creosote. It is a product of distillation of coal-tar collected between 200–400°C. and consists of a variety of products but principally of the tar acids, the tar bases, and the neutral hydrocarbons. For wood preservation purposes, it is recommended that it may be used in admixture with petroleum oils in the ratio of 50 : 50 by weight. While it can be used for treatment of timber for all purposes, it is preferable to avoid its use in dwelling houses and transmission poles where its odour and colour are objectionable and its defects such as tackyness, and un-paintability of timber treated with it are a hindrance. It is produced in India to the extent of about 3,600 tons per year. If necessary its production can be increased. Solignum and Creosant are two proprietary preservatives containing high boiling creosote as a base and these are used for brush treatments.

(*b*) *Water soluble type*—These consist of inorganic and organometallic salts soluble in water. To prevent leaching of these preservatives from treated timber to be used in the open, generally sodium dichromate is added to fix them. Copper sulphate, zinc chloride, boric acid and borax, and sodium pentachlorophenate form some of the leachable type.

Copper sulphate is quite toxic against both fungi and insects, whereas zinc chloride is not so toxic. Boric acid and borax are quite toxic against boring insects particularly, *Lyctus* species. These two preservatives are specially to be used for treatment of box timber for packing consumable articles, such as tea, tobacco, etc. Sodium pentachlorophenate is generally effective against staining type of fungi which do not materially destroy the strength of timber, except its toughness.

TABLE No. 15

Table showing the effect of preservative treatments on the natural resistance of semul *and* chir *timbers against fire*

Serial No.	Species treated	Preservative tried	Absorption of preservative in lbs./cu. ft.	Percentage weight of the treated specimen lost on exposure to flame for 2 minutes
1	2	3	4	5
1	*Semul* (*Bombax malabaricum*)	Untreated	Nil	84·14
2	,,	ASCU	0·91	80·27
3	,,	,,	1·40	75·69
4	,,	,,	1·25	75·30
5	,,	Creosote and Fuel oil (1 : 1)	10·30	83·20
6	,,	,,	7·74	80·28
7	,,	,,	3·78	81·21
8	,,	Pentachlorophenol	0·54	81·88
9	,,	,,	0·58	82·77
10	,,	,,	1·98	84·48
11	,,	Copper naphthenate	0·99	82·89
12	,,	,,	0·88	83·38
13	,,	Zinc chloride	0·22	76·57
14	,,	,,	0·68	69·55
15	,,	,,	1·27	53·90
16	*Chir* (*Pinus longifolia*)	Untreated	Nil	84·30
17	,,	ASCU	1·38	73·32
18	,,	,,	2·07	70·99
19	,,	Creosote and Fuel oil (1 : 1)	15·75	83·89
20	,,	,,	8·35	83·85
21	,,	,,	3·45	83·56
22	,,	Pentachlorophenol	0·72	82·98
23	,,	,,	0·98	82·48
24	,,	,,	1·51	82·95
25	,,	Copper naphthenate	0·72	84·88
26	,,	,,	1·14	85·07
27	,,	,,	1·24	85·30
28	,,	Zinc chloride	0·35	76·20
29	,,	,,	0·50	72·44
30	,,	,,	1·52	46·50
31	,,	,,	2·02	30·20

PLATE No. 8

Fire-proof-cum-antiseptic treatment undertaken for the first time at Forest Research Institute. Treated sleepers ready for despatch to undergo service tests in the line.

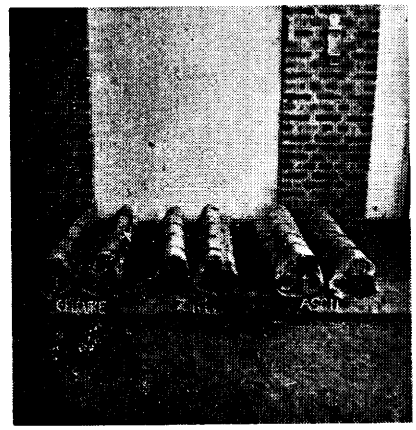
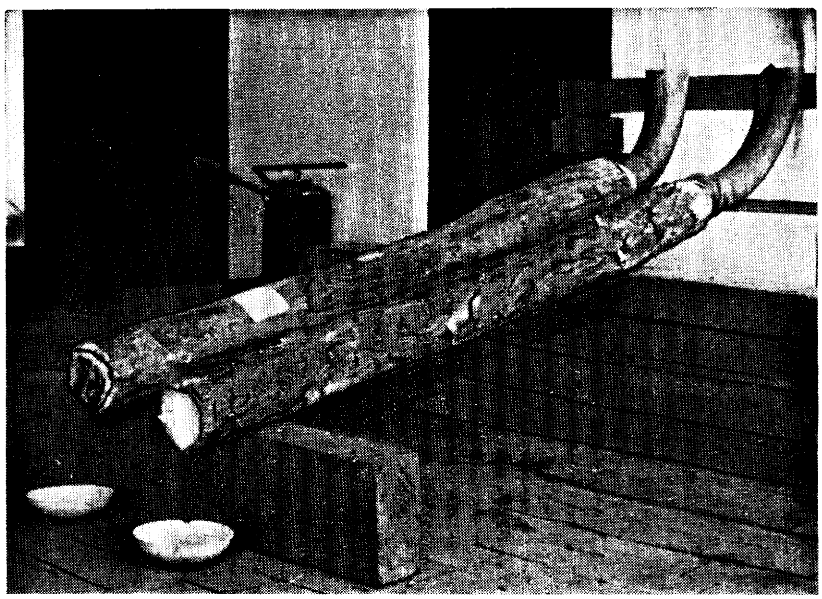


PLATE No. 9

Treatment of green poles by the Osmose Process of *chir*, *sal* and *teak* species. The specimens are wrapped with 'alkathene' film.

PLATE No. 10(*a*)



Normal Boucherie treatment of green poles using old tyre inner tubes as reservoir.

PLATE No. 10(*b*)

Boucherie treated *chir*, *sal* and *teak* posts undergoing service tests in the "Graveyard" at Forest Research Institute.

Illustrations showing low pressure treatment of green logs and bamboos.

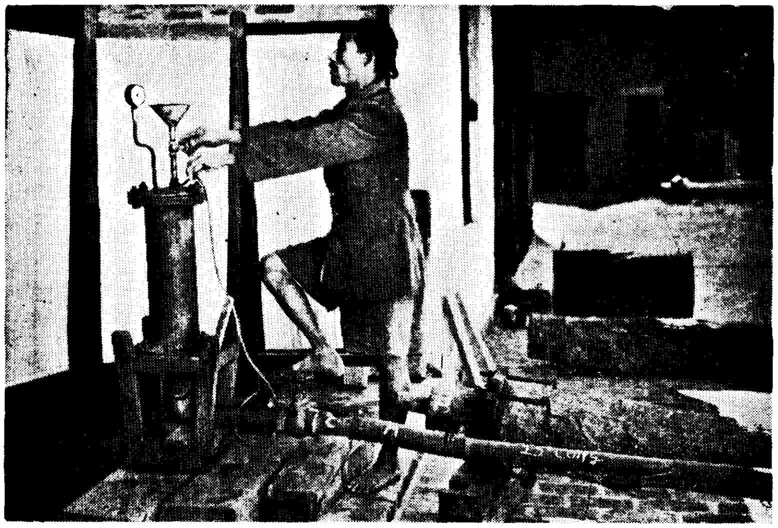


PLATE No. 10(*c*)

PLATE No. 10(*d*)

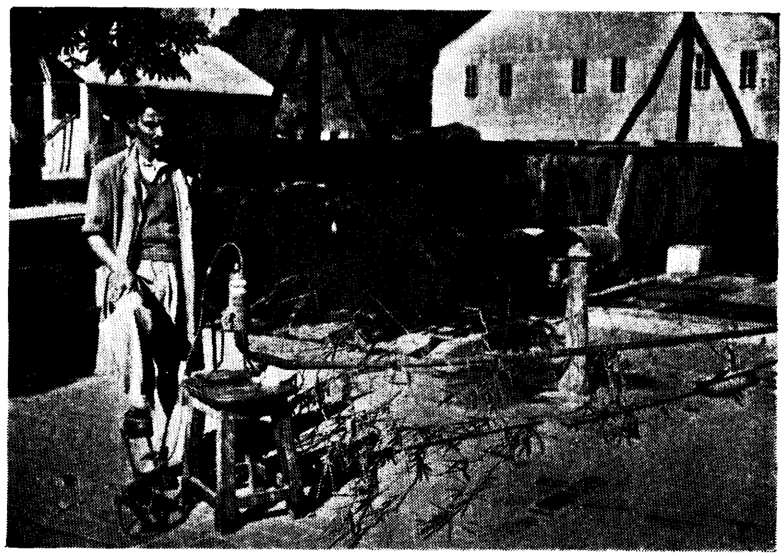


PLATE No. 10(*e*)

As regards fixed types of preservatives which can be used both in inside and outside locations, Ascu, Celcure, Boliden salts (S25), Copper-chrome-boric composition and Chromated zinc chloride may be mentioned. Except for the last preservative, the others are proprietary ones. For Government purposes, however, Ascu can be compounded and used freely. The advantage of these preservatives above the oil type is that timber treated with them can be painted over and varnished.

(*c*) *Organic solvent type*—These consist of copper and zinc salts of organic acids such as naphthenic acid, stearic acid, and abietic acid, etc., and chlorinated phenols and benzenes like pentachlorophenol and hexachloro-benzene, and chlorinated naphthenates. These are used after dissolving them in suitable organic solvents of low boiling point so that when the treated timber dries up the solvent evaporates off leaving the preservative behind. Hardiproof and Cuprinol are two proprietary preservatives of the above type containing copper naphthenate as a base. Timbers treated with the above preservatives can be painted and varnished, and as such these can be taken as ideal preservatives for brush painting household furniture, tool handles, etc.

METHODS OF APPLICATION OF PRESERVATIVES[25]

Preparation of timber for treatment—Whatever be the process of treatment to be adopted, timber accepted for treatment should be sound, debarked thoroughly, dried below 25 per cent moisture content, and if there is any wood working to be done, including cutting to sizes, etc., it should be completed first. In the case of timbers whose heartwood is non-durable and refractory to treatment, incision of all the surfaces other than the ends to a depth of 1/2 to 3/4 inch is necessary for proper penetration of the preservative.

Surface application—This may be done by brush, spray or dipping in the preservative fluid for a short period. In the case of brush treatment, and spraying, the second application should be taken up after the first has dried. With the oil type of preservatives, the moisture content in wood must not be more than 10–14 per cent. With aqueous solutions, however, it is permissible to have a moisture content up to 20–30 per cent. Where permissible, the treatment should be done hot.

Surface treatment has limited scope only, *viz.*, treating the material at site and for retreatment of cut surfaces, etc.

Soaking and Diffusion treatments—The soaking treatment is done by submerging the dried timber in the preservative solution for a long period when slow absorption of the preservative takes place.

If the timber is green and is submerged in a water soluble preservative for a long period – 3 to 12 weeks depending on the size of timber – it penetrates into the timber by ionic diffusion. Another type of diffusion treatment called the Osmose process is carried out by applying a paste of an inorganic preservative on the green and debarked timber surface and stacking it in solid piles with a cover of any water-proof sheeting material, *vide* Plate No. 9. M/s. Imperial Chemical Industries (India) Ltd., stock such a material called "Alkathene".

While the soaking process is suitable for veneers which can be treated quickly, the Osmose process is applicable only to freshly felled timber in the round, such as poles. Green canes are best treated by the diffusion method.

Hot and Cold process—In this process the timber is submerged in the preservative fluid which is then heated to about 100°C. and maintained at that temperature till the charge attains the temperature of the bath. It is then allowed to cool down to the atmospheric

temperature or any temperature higher than that, determined mainly by the required absorption of the preservative. During the heating period the air in the timber expands and is partially expelled ; during the cooling period, the residual air in the timber contracts, thus creating a partial vacuum under which the preservative is sucked in. The treatment also ensure sterilization of the timber from any decay organism or insects that may be present originally. In the absence of facilities for pressure treatment this process is recommended for timber containing sapwood and easily treatable heartwood. With in organic fixed type of preservatives, however, there is a danger of precipitation of the chemicals at high temperatures and in content with the reducing materials in timbers. To overcome this difficulty two baths are used ; the first containing water where the hot treatment is given and the second the cold bath containing the preservative to which the timber is transferred immediately thereafter, *vide* Fig. No. 4.

The Boucherie process—With the Boucherie process, treatment of the sapwood of almost all green timbers and the heartwood of easily treatable species and bamboos, can be done using any of the inorganic water soluble preservatives. The treatment is done by attaching the butt end of a pole with bark on, to a reservoir (generally for treating individual bamboos or poles, old tyre inner tubes are used) containing the preservative solution at a higher level. The pole is generally held in an inclined position preferably at an angle of 45° to the ground. Due to hydrostatic pressure, the preservative displaces the sap in the timber which flows out from the thin end. The treatment is stopped when the concentration of the drip is the same as that of the solution in the reservoir, *vide* Fig. No. 5 and Plate Nos. 10(*a*) and (*b*). In the case of bamboos, the basal internode is made use of as the reservoir and since the inner surface of the bamboo is not permeable, it is incised nearest the septum of the node used as the reservoir. The bamboo is held in a vertical position. Strictly for wood preservation, however, these methods have not so far gained commercial success.

In recent[27] experiments conducted in the Wood Preservation Branch of the Forest Research Institute, air pressure of 10–30 lbs./sq. in. has been used over the preservative in the original Boucherie method of treating green timber and bamboos, *vide* Plates 10(*c*), 10(*d*)and 10(*e*). These air pressures are intended to ensure better and quicker penetration and absorption of the preservative, and particularly to eliminate the unwieldy method of application of hyrostatic pressures involving the raising of the log or bamboos or the reservoir several feet above the ground.

Plate 10(*c*) illustrates the case where a bamboo over 25 feet long or a log 15–20 feet long, is fixed to the apparatus at 'C' either through a pressure rubber tube 'A' attached to the bamboo or a special clamp 'B' fixed to the log. In either case instead of the usual butt end, the thin end of the bamboo or log is attached to the apparatus since this has been found more convenient. The flow of the preservative, under the above pressure, through the green material has been found quite satisfactory. With suitable attachments over a dozen bamboos can be attached to this apparatus and treated simultaneously. For treating individual bamboos, the apparatus in Plates 10(*d*) and (*e*) can be used. In 10(*d*) a container about 1–2 litre capacity is used as a reservoir and in 10(*e*) a hose pipe of a suitable size is used, the open end being closed (after pouring in the preservative) with a rubber stopper in which a bicycle tube valve is fixed. With these arrangements it is not necessary to incise the walls of the bamboo as the cut-end itself is sufficient to give entrance to the preservative into the walls of the bamboo.

With the above arrangements it was found possible to treat freshly felled *chir*, mango, *sal*, and teak logs and bamboos. Since treatment of bamboos has assumed considerable importance in our community projects, collection of data on the treating characteristics of the bamboos was first taken up.

So far the following species of bamboos were investigated: *Bambusa nutans*, *Bambusa polymorpha* and *Dendrocalamus strictus*. As regards the preservatives, ASCU was used in 10% concentration, zinc chloride 15 per cent together with 2% sodium dichromate and Boliden salts (S25) 4%. The bamboos were all cut to 21 feet length but belonged to different age groups. It was found that up to 3 seasons old, they (including the septa) could be satisfactorily treated, the period of treating being 3 hours for outside use, 2 hours for inside use and half an hour for prophylactic purposes. Beyond the age of three seasons there appears to be considerable resistance to the flow of the preservative under the low pressures of 15–20 lbs./sq. in. Possibly higher pressures up to 30 lbs./sq. in. may be required to treat bamboos over 3 seasons old, but it remains to be settled at what minimum age the bamboo attains strength sufficient for structural use. Investigations on this direction are now proceeding in the Timber Mechanics Branch of this Institute.

PRESSURE PROCESSES (*vide* Fig. 6)

Full Cell process—The Full Cell or Bethell process is used when the largest volumetric injection of the preservative is desired. The process is carried out as follows: The timber charge is introduced into the cylinder, and the door is tightly closed and then a vacuum of at least 22 inches Hg. is drawn. The object of the last operation is to remove as much air as possible from the wood cells. When the vacuum has been maintained for a period of about half an hour the preservative is introduced into the cylinder, with the vacuum pump working. When the cylinder has been filled with the preservative the vacuum pump is stopped and the cylinder is subjected to an antiseptic pressure (50–175 lbs./sq. in.) depending on the species, size, refractory nature of timber, etc. This injects the preservative into the timber. The pressure is held until the desired amount of absorption is obtained, when the preservative is withdrawn from the cylinder and finally a vacuum (15 to 24 inches Hg.) for about 15 minutes is applied to free the timber from dripping preservative. Specified retentions of toxic chemicals in timber during treatment can be had by a proper selection of the concentration of the toxic material in the treating solution and by a judicious control of the absorption of the preservative solution during the process of injection.

Empty Cell process—These aim at a maximum penetration of the preservative with a minimum of net absorption and are commonly known as the Lowry and the Rueping processes.

Lowry process—In this process the cylinder is loaded with the timber and closed. It is then filled with the preservative – the air in the cells of the timber being imprisoned. An antiseptic pressure of 50 to 175 lbs./sq. in. depending on timber species, size, etc., is now applied till the required absorption is obtained. The pressure is then released, when a part of the preservative injected into the timber is expelled. The cylinder is then drained off, and finally, a vacuum is applied.

For treatment of timber, bamboos and grasses used for house building purposes and for treatment of timber for packing cases, however, a portable low pressure treating equipment shown in Fig. 7 will be found most suitable.

Rueping process—In this process the timber is introduced into the cylinder, which is then closed. An air pressure (25 to 75 lbs./sq. in.) is then applied for a specified period depending on the sapwood content and is maintained during the subsequent step of filling up the cylinder with the preservative. When the cylinder is filled, an antiseptic pressure (75 to 175 lbs./sq. in. depending on species, size, etc.) is applied till the required absorption is obtained followed by a final vacuum. In this case the preservative expelled on the release of the antiseptic pressure, is considerable, yielding low net absorption. This process is specially recommended for treating timber of mixed species and also timber containing both sap and heartwood.

Steaming-cum-vacuum-cum-Boulton process—This process is specially recommended for treatment of green timber that is easily amenable to decay due to fungus during the course of air seasoning in warm and humid climates. It consists in steaming a timber charge at about 20 lbs. gauge pressure for a period depending on the size and moisture content of the timber and then subjecting it to a vacuum. Under these conditions considerable reduction in the moisture content of the timber is effected. The charge is then subjected to any one of the types of preservative treatments mentioned above.

If a further reduction in the moisture content is desired before giving the preservative treatment, as in the case of certain species of timber for use as sleepers, poles, etc., the Boulton process is followed. This consists in boiling the timber under application of a gradual vacuum in the presence of a suitable oil, preferably a preservative like creosote-fuel-oil-mixture if ultimately the timber is to be creosoted. Creosoting is completed by employing the types of treatment mentioned above, generally the pressure processes are used.

Choice of Treatment—The choice of treatment will be governed by the timber species, its sapwood content and the use to which it is to be put. Treatment is necessary in the case of (1) sapwood of all the species of timber, (2) heartwood of non-durable species and (3) heartwood of even the durable species if the members are to be placed in the ground and are expected to give long life under severe conditions of deterioration. The recommended practice with regard to choice of preservative, treatment process, absorption and penetration to be adopted is given in Table No. 16.

TREATING EQUIPMENT

It is not yet found possible to manufacture completely commercial size pressure treating plants in India. Except for minor accessories like the storage tanks, steam coils, trollies, etc., the rest as specified below, has to be imported from U.K., Germany and U.S.A. Hot and cold treating plants (open tanks), Boucherie treating plants and low pressure treating plants can, however, be manufactured in India. Imported articles like, cranes, pulley blocks, vacuum and centrifugal pumps are available in Indian market.

SPECIFICATION FOR A PRESSURE TREATING PLANT FOR ALL PURPOSES

1. *Cylinder*—The cylinder should be made of mild steel of a suitable size say, 8 feet in diameter and 45 feet long, with doors at each end. The doors must have tongue and groove arrangements for closing tightly by means of necessary clamp bolts capable of maintaining a vacuum of 30 inches of mercury and a working pressure (hydraulic) of 200 lbs. per sq. in. The cylinder must be tested for a maximum pressure of 360 lbs./sq. in. It should be of rivetted construction with all seams double rivetted, circumferential seams lap-jointed and longitidunal seams butt-strapped. It should also be fitted with one set of M.G. bogie rails running full length throughout the cylinder and one set of guard rails to prevent bogies from lifting. The doors must be provided with necessary cranes for opening and closing operations.

The cylinder should also be provided with necessary (4 runs of 2·1/2 inches steam piping) steam coils, at the bottom – between and below the bogie rails, and also a connection for inlet of live steam. The steam coils should be protected on the top with a perforated metal plate. The cylinder should also be complete with all necessary gauges and fittings including one protected level gauge, one vacuum gauge, one pressure gauge, two safety valves, two vent cocks, three 6 inches bore bottom connections to the storage tank, one 4 inches bore connection for vacuum, one 2·1/2 inches connection for pressure feed, two 1 inch bore return pipes from vents to storage cylinder, one feed check valve for pressure line, and all necessary cocks and valves.

FIG. 4

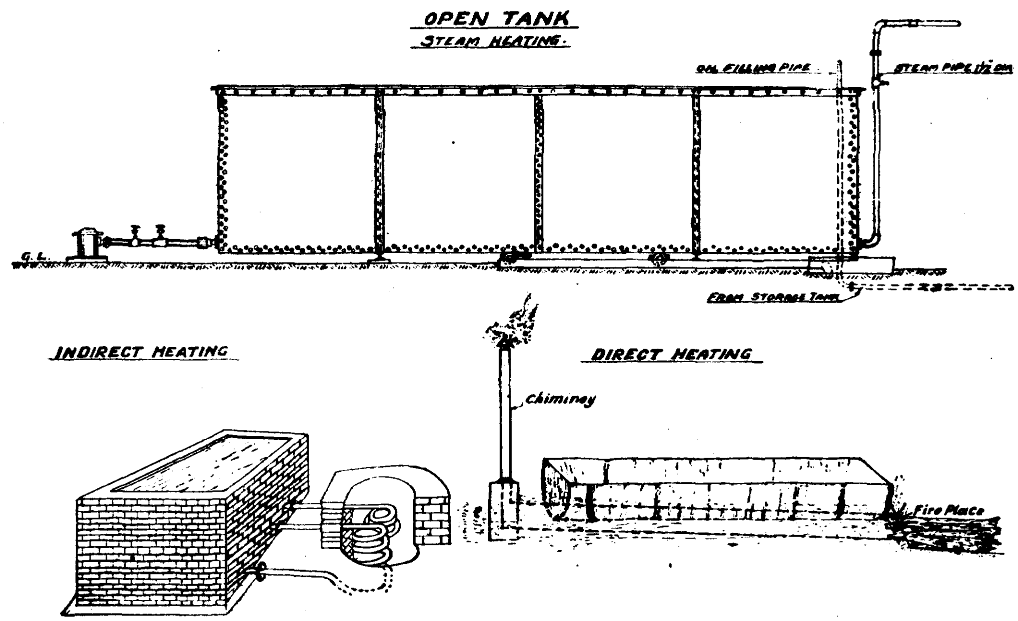

OPEN TANK
STEAM HEATING
OIL FILLING PIPE
G.L.
FROM STORAGE TANK
INDIRECT HEATING
DIRECT HEATING
Chimney
Fire Place

FIG. 5

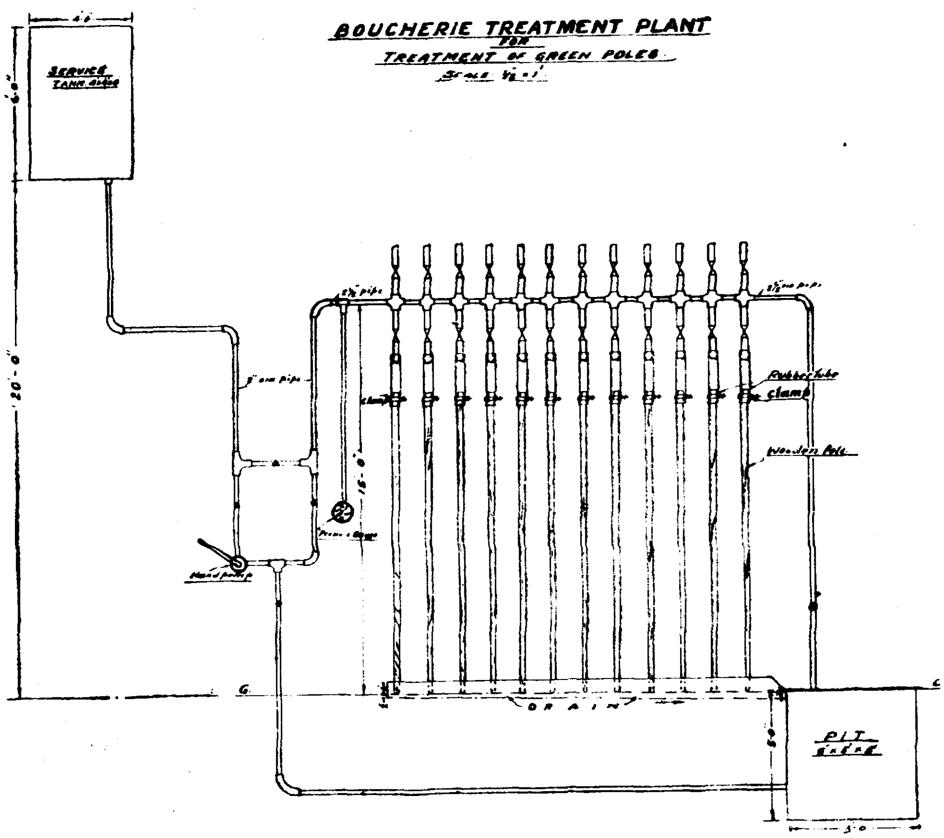

BOUCHERIE TREATMENT PLANT
FOR
TREATMENT OF GREEN POLES
SERVICE
20'-0"
Rubber tube
clamp
Wooden Pole
Hand pump
G.
DRAIN
PIT

FIG. 6

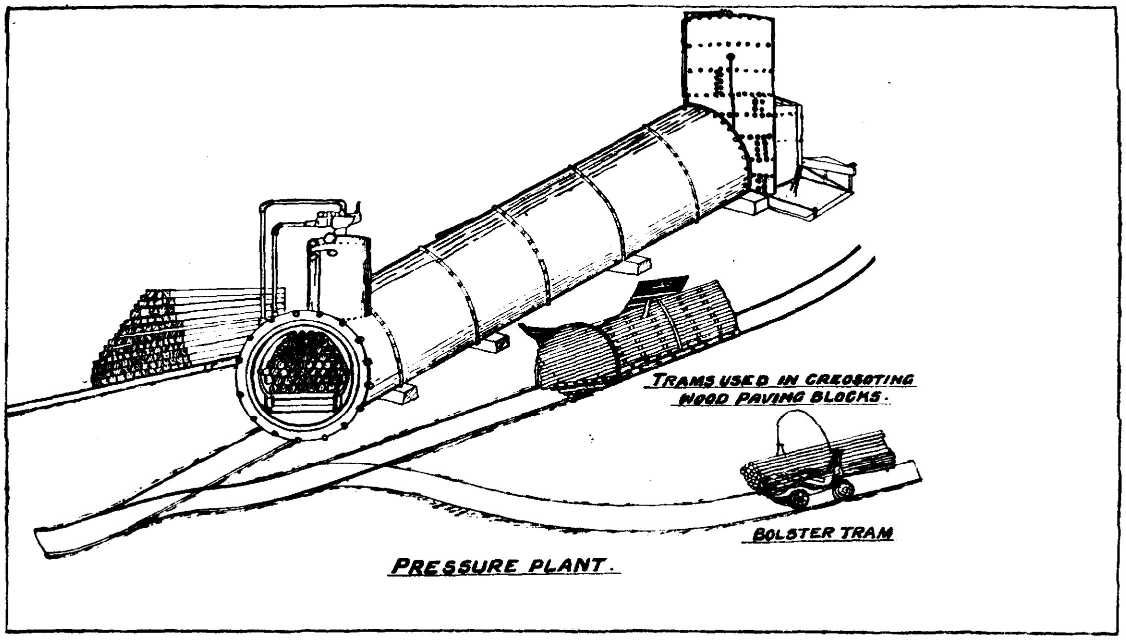
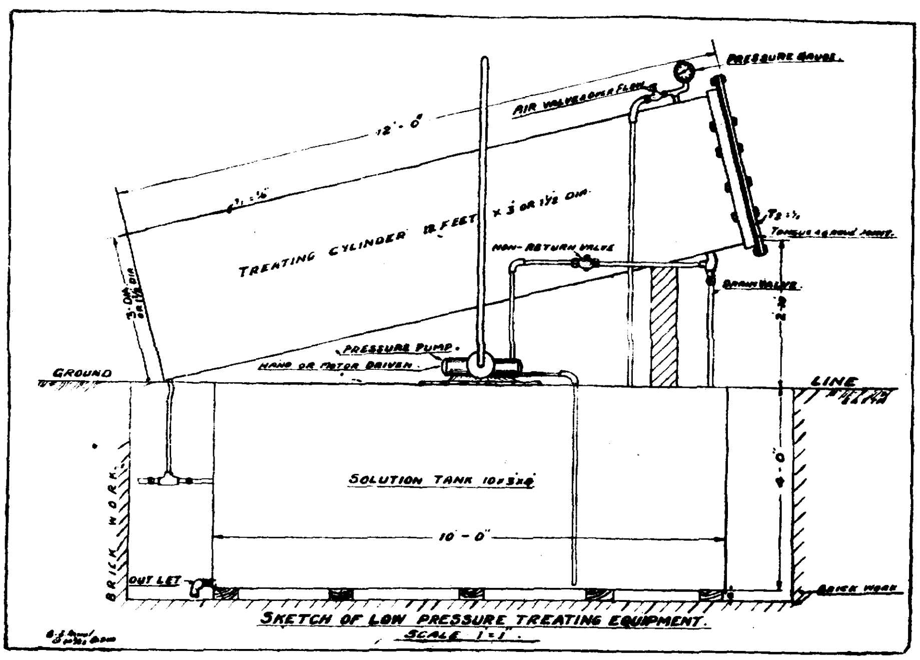

TRAMS USED IN CREOSOTING
WOOD PAVING BLOCKS.
BOLSTER TRAM
PRESSURE PLANT.

FIG. 7


AIR VALVE & OVER FLOW
12' - 0"
TREATING CYLINDER
NON-RETURN VALVE
DRAIN VALVE
PRESSURE PUMP.
HAND OR MOTOR DRIVEN.
GROUND
LINE
SOLUTION TANK
10' - 0"
OUT LET
BRICK WORK.
BRICK WORK
SKETCH OF LOW PRESSURE TREATING EQUIPMENT.

2. *Foundation girders*—One complete set of six 12 × 6 inches rolled steel joists to span the storage tank pit for supporting the impregnating cylinder together with suitable chocks for the end joists.

3. *Vacuum pump*—One 10 × 10 × 5 inches direct acting air compressor and vacuum pump attached with water jacket pump and capable of compressing air to 60 lbs. per sq. in in a cylinder 50 feet long and 8 feet diameter allowing the cylinder to be 50 per cent full of timber ; time of operation is 0·5 hour. After the cylinder has been drained of the preservative a final vacuum is to be created to draw off the surface oil, which operation should also take 0·5 hour only.

4. *Pressure pump*—One 4 × 2·1/4 × 4 inches Duplex pump all iron or steel feed capable of raising the pressure from 60 to 180 lbs. per sq. in. in 0·5 hour.

5. *One sump pump*—(Items 3, 4, 5 and 6 may be either steam or electrically driven. Separate quotations may, therefore, be obtained).

6. *Condenser and piping*—A water cooled condenser of suitable size for condensing vapour, water and oil in the vacuum line.

7. *Piping*—All liquor and vacuum piping between the storage tank, impregnator, vacuum pump and pressure pump, comprising three main 6 inches liquor connections each fitted with a stop valve ; two 1 inch bore return pipes from vent cocks to storage tank ; two 1·1/2 inches bore pipes between drip trays and storage tank, each fitted with a stop valve ; one 4 inches bore suction main between impregnator and vacuum pump with stop valves ; one 2·1/2 inches bore connection between pressure pump and impregnator with a stop valve ; one 2·1/2 inches bore suction pipe from storage tank to pressure pump with a stop valve ; four stop valves for connections to and from steam heating coils ; and 1·1/2 inches bore suction pipe and strainer for sump pump.

One goose neck connection (about 40 feet in height) is to be given between the cylinder and the condenser.

8. *Service tank*—One M.S. storage tank of the same capacity and length as the cylinder and tested for oil tightness to 10 lbs. per sq. in. provided with two man holes and covers and suitable connections for return pipes from door drip trays and vent cover flows on impregnator. This tank is also provided with one set of 4 runs of 2·1/2 inches bore steam piping in the bottom and two main branches for connections and to the piping in the bottom, and two main branches for connections and to the impregnators, each of these branches being provided with 6 inches bore dip pipe and strainer. The tank is to be provided with a float gauge and a calibrated scale so that the quantity of the liquid in the tank may be read off at any time.

9. *Bogies*—24 M.G. bogies each 56 inches long with wheel base 3 feet 6 inches centres × one meter gauge. The bogies to be fabricated of M.S. Section fitted with G.I. flanged wheels and to be complete with chains, stretches and bales, drag links for coupling bogies together.

10. *Storage tanks*—Of suitable capacities for storing about 3 lac gallons of each of creosote and fuel oil. In addition a mixing tank of about 5,000 gallons capacity is also required.

11. Recording thermometer and gauges for vacuum and pressure should also be supplied.

12. Diesel movable crane on tyres with a 4 tons lift capacity.

13. Track Scales for weighing loads of sleepers and poles on the trolley.

14. Adzing, boring, incising and pole shaping machines – one set.

TABLE

Group	Uses of treated timbers	Process
1	2	3
I	Timbers in direct contact with or embedded in the ground or water, especially in outside locations, e.g., poles, piles, fence posts, sleepers, bridge timbers and timbers for ship-building, etc., classes I to VI containing sapwood, and heartwood of timbers belonging to Classes III, IV, V and VI if treatable (Fig. 2). For protection against marine organism attack, treatment in the heartwood and sapwood is necessary for all Indian timbers.	Pressure or hot and cold process (if treatable), Osmose or Boucherie process wherever practicable.
II	Timbers not in direct contact with the ground but exposed (Timbers as in I).	Pressure or hot and cold process (if treatable).
III	Timbers not in direct contact with the ground but exposed, and in addition given a coat of paint or varnish regularly after preservative treatment, *viz.*, weather-boards, fence rails, etc. (Timber as in I).	Pressure or hot and cold process (if treatable).
IV	Timbers for internal uses in dry locations. (Timbers as in I).	Pressure for class VI ; hot and cold process for class V ; soaking for class IV ; and brushing or spraying for classes III to I.
V	Shooks, packing cases, etc.	Low pressure (25–50 lbs./sq. in.) or hot and cold process or dipping or soaking or brush or spray depending on the protection required.
VI	Debarked logs and converted timber for use in the plywood, match, paper, etc., industries. (Green timbers susceptible to sap stain attack especially during humid and hot weather).	Brush or spray treatment for prophylactic purposes.

* Percentages in column 4 refer to strength of solutions to be used for dipping, soaking, brush or spray treatment. For pressure process and open tank treatment the absorptions are indicated in column 5 and refer to the non-durable portions of timbers. Unless otherwise stated the above treatments ensure protection against fungal decay, termite and borer attack.

† Indicates proprietary preservatives.

Penetration of the preservative

For Group I.—In the case of timbers to be embedded in the ground like transmission poles, piles, etc., it is necessary to have 1·1/2–2" ring of sapwood and care taken that the penetration of the preservative is complete in the entire sapwood portions ; penetration in the non-durable heartwood in addition, would ensure a satisfactory service life. In the case of sleepers while it is best that the penetration is through and through in the sap and non-durable heartwood portions, a minimum penetration of 1–1·1/2" is essential. Where the heartwood of the non-durable timbers is refractory to treatment, incision as already remarked of all the surfaces excepting the ends to a depth of $\frac{1}{2}$" to $\frac{3}{4}$" is required. Use of half round sleepers after treatment is recommended in this connection.

For Group II–V.—In the case of timbers under Group II to V while the sapwood portions should be completely treated, a minimum penetration of $\frac{3}{4}$" in the case of Group II and III, $\frac{1}{2}$" for Group IV and $\frac{1}{4}$" in the case of Group V is essential.

No. 16

Recommended preservative*	Absorption lbs./cu. ft.		
4		5	
	Sleepers	Poles, piles and fence posts	Marine structures
(*a*) Creosote-fuel-oil mixture (50 : 50)	5 to 8	10	20
(*b*) *ASCU*† *Celcure*†	0·5	1·0	2·0
$As_2O_5, 2H_2O$ = 1 part by wt. $CuSO_4, 5H_2O$ = 5·5 parts by wt.	..	..	..
$CuSO_4 5H_2O$ = 3 parts by wt. $Na_2Cr_2O_7$ = 5·5 parts by wt.	..	..	..
K_2 or $Na_2Cr_2O_7$ = 4 parts by wt. Acetic acid = 0·2 part by wt.	..	..	..
(*a*) Creosote-fuel-oil mixture (50 : 50)	3 to 5	..	..
(*b*) Ascu ; Celcure	0·5 to 0·75	..	..
(*a*) Ascu ; Celcure	0·4	..	..
(*b*) Pentachlorophenol	0·3	..	..
(*c*) Copper naphthenate	0·3 to 0·4	..	..
(*a*) Ascu ; Celcure	0·3 to 0·4	..	..
(*b*) Chromated zinc chloride (1 : 1)	1·0 to 2·0	..	..
(*c*) Zinc chloride	0·75 to 1·0	..	..
(*d*) Copper naphthenate	0·25	..	..
(*e*) Pentachlorophenol	0·25	..	..
(*f*) Creosant or Solignum for hot brush treatment	..	..	..
(*a*) Ascu 6·0%	0·3 to 0·5	..	..
(*b*) Celcure 11·2%	0·5	..	..
(*c*) Chromated zinc chloride (1 : 1) 12·0%	1·0	..	..
(*d*) Zinc chloride 8·0%	0·5 to 0·75	..	..
(*e*) Pentachlorophenol 5·0%	..	..	..
(*f*) Copper naphthenate 10·0%	..	..	..
(*g*) Boric acid or borax (for *Lyctus* attack) 2 to 2·5%	..	..	..
(*a*) Ascu 6% ; Chrome-copper-boric acid composition 6% ; Chrome-zinc boric acid composition 8% (Prophylactic treatment against fungus)	..	..	..
(*b*) Sodium pentachlorophenate (for sap stain) 1·0%	..	..	..
(*c*) Gammexane (for borers)† in water emulsion (Timbers treated with (*b*) and (*c*) should be kept under cover) 1·0%	..	..	..

15. Locomotive for loading unloading the cylinder.

16. *Boiler*—One Cochran patent Vertical multi-tubular boiler, class A, standard, 15 feet 0 inch high × 7 feet 0 inch diameter with a heating surface of 600 sq. feet and with a steaming capacity of 2,000 lbs. of steam per hour from wood fuel using cold feed water.

The boiler is to be complete with feed pump and funnel, steam and water mountings, and the necessary fittings for wood firing by hand. The boiler is to be offered with a special well-type grate which is an arrangement whereby the grate level is lowered to give a very thick fire bed which is an advantage when wood fuel is used. The boiler should be capable of giving 150 lbs./sq. in. steam pressure.

The boiler should comply with all Indian Boiler Regulations and should be provided with the necessary certificates.

17. A steam winch of 4 tons capacity for hauling timber poles from the ship to the yard on a sloping skid, if required.

Note—For treatment with water soluble preservatives the same plant can also be used; but if conditioning of timber prior to treatment is not necessary, steam piping and boiler may be deleted from the specification.

The above plant has a treating capacity of 1,100 c. ft., i.e., is capable of treating 360 B.G. sleepers or 72 poles of 8 inches dia. and 40 feet long per charge.

With creosote generally 2–3 charges, and with water soluble or solvent type of preservatives 3–4 charges can be treated per day working single shift of 8 hours. It will be economical if the plant is worked continuously for all the 24 hours and for 300 days a year.

SPECIFICATION FOR THE OPEN TANK PLANT FOR THE TREATMENT OF TIMBER BY THE HOT AND COLD PROCESS

1. One pressed steel tank 40 × 6 × 6 feet capacity 9,000 gallons, complete with stays, cleats, bolts, nuts and jointing material.

2. Steam heating coils fabricated from 1·1/4 inches mild steel tubes in length suitable for rail transport fitted with 1·1/2 inches return bends and socket unions – at least 14 such coils will be required all along the length at the bottom.

3. One bottom service tank (may be of masonry) of the same capacity (9,000 gallons) as per item 1, for storing the drained oil while the timber is being unloaded and fresh charge loaded in the tank (item 1).

4. One centrifugal pump for pumping in the oil from items 3 to 1, and to item 5 below.

5. Two mild steel welded storage tanks, each about 20,000 gallons capacity, fitted with 4 steam coils (1·1/4 inches) at the bottom for warming the oil.

6. Marshall No. 6 'Trent' type vertical cross tube Boiler rating 6 N.H.P.

7. Two recording thermometers range 0° to 100°C.

8. One crane and hoist for loading and unloading poles to and from the treating tank.

9. Miscellaneous items, like platform weighing machines, steam traps, external pipe work, valves, wooden protective battens for steam coils and sloping cement platform for keeping freshly treated poles to collect drippings, and cross-bars to keep the timber charge submerged in the preservative during treatment.

Note—The above plant has a capacity for treating 12,000 poles or 72,000 B.G. sleepers or 2 lacs cubic feet of timber a year.

TECHNICAL PERSONNEL AND LABORATORY

Technical personnel employed in Wood Preservation plants should be properly trained to ensure efficiency. Facilities for such training are available at the Forest Research Institute. The plant manager should be at least a M.Sc. in physical science, or a graduate in mechanical or chemical engineering. He should be provided with a well equipped laboratory so as to enable him to carry out the chemical work involved (*vide* Appendix).

METHOD OF CALCULATING THE COST OF TREATMENT

Details on the requirements of supervisory and labour staff, and the method of calculating the cost of treatment are given below :—

DATA

1. *Capital outlay on treating plant and buildings*—Rs. 6·25 lacs.
2. *Details of Supervision charges*

		Pay p.m. Rs.	Pay annually Rs.
Superintendent ..	.. one	600	7,200
Assistant Superintendent	.. one	300	3,600
Store keeper ..	.. one	150	1,800
Clerks ..	.. three	300	3,600
Head Mechanic (Foreman)	.. one	150	1,800
Fitter Mechanics ..	.. two	200	2,400
Boiler Man ..	.. one	120	1,440
	Supervision Charge say	..	22,000

3. *Labour Charges*

Head carpenter ..	.. one	150	1,800
Carpenters ..	.. six	600	7,200
Firemen ..	.. two	180	2,160
Coolies (including chowkidars)	.. six dozens	3,600	43,200
Gatemen ..	.. two	180	2,160
Sweepers ..	.. two	120	1,440
		Total ..	57,960
		Say ..	58,000

4. *Details of the quantity of Timber Treated*

Volume of the treating cylinder (6 feet diameter and 75 feet long)	1,980 cu. ft.
Treating capacity (taken as 50% of the volume) ..	990 ,,
Say ..	330 B.G. sleepers
Number of sleepers to be treated per day of about 3 charges (one shift)	990 ,,
Number of sleepers per year taking 20 charges per week and 40 weeks per year	2,64,000 ,,
or Say ..	8 lacs cu. ft.

5. *Cost of Treatment per cubic foot of Timber with Creosote-Fuel Oil Mixtures*

	Rs.	As.	Ps.
Cost of creosote-fuel oil (50 : 50) mixture at 1/2 gallon (5 lbs.) per cu. ft.	0	10	6
Supervision charges	0	0	5·3
Labour charges	0	1	2
Interest at 3% per annum (on 6·1/4 lacs Rupees total investment on plant and building)	0	0	4·5
Depreciation at 10%	0	1	3
Boiler charges	0	0	8·3
Office contingency	0	0	4
Electricity	0	0	3
Losses due to rejection of sleepers due to splitting and other mechanical failures	0	0	9
Total ..	0	15	9·1
Add 5% contingency ..	0	0	9·0
GRAND TOTAL ..	1	0	6·1

Say Rs. 1–0–6 per cu. ft.

METHOD OF CALCULATION OF ANNUAL CHARGE

The annual charge is defined[4e] as "cost per year of the annual payment required to extinguish an interest bearing debt during a period of years corresponding to the life of the material in service" and is calculated by using the formular $A = P\left\{ r + \frac{r}{(1+r)^n - 1} \right\}$, in which A is the annual charge, or cost per year ; P is the first cost of the material (in place) ; r is the rate of interest (expressed as a decimal) ; and n is the number of years of service expected from the given installation.

To give an illustration, let is consider the following example[28].

DATA	Rs.
1. Cost of thatching 100 sq. ft. roof with 6 inches thick layer of grass	25
2. Cost of chemical treatment to protect the above against decay and insect attack	20
3. Service life of untreated grass	3 years
4. Service life of treated grass..	15 ,,

Taking the interest at 5% (including interest at 3% and maintenance charge at 2% on capital cost) the annual charge for the untreated roof using the above formula comes to Rs. 9·18, and for the treated roof Rs. 4·34. It will be thus seen that inspite of an increase of Rs. 20 or 80% on the initial cost of roofing due to treatment, the net saving as a result of treatment will be Rs. 4·84 or 52% per year.

Details on the cost and addresses of suppliers of preservatives, treating plants, and yard lay-out are given in the Appendix.

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DECAY AND SAP STAIN OF TIMBER, THEIR CAUSES AND PREVENTION

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SUMMARY

The paper lays down practical directions that should be followed to prevent decay and sap stain of timber from the time a tree is felled till the timber is converted. Fungi which cause decay and stain in timber usually remain active between June–July to September–October in India when the hot season coincides with the monsoon rains. Infection and subsequent growth of fungi into the wood is frequent and rapid during this period. During the remaining months of the year, the fungal activity is reduced to a minimum and the infection of wood is correspondingly reduced. Inside the wood, the fungi cannot grow if the wood is saturated with water or if the moisture content of the wood is brought below 20 per cent based on oven-dry weight of the wood. The food requirements of wood destroying and sap stain fungi and their effects on the wood are described. Methods of identifying decay and stain fungi in culture are described and the practical utilities of such determinations are stressed.

Felling time should preferably be in winter when the fungus activity is minimum due to low humidity and temperature. The tree should be cut into smaller logs, barked and the surface brushed with a preservative within 48 hours after felling to give a temporary protection to the timbers. They should be quickly transported to timber yards where they may be stored completely submerged in water in log ponds or stored dry in storage yard. Hygienic methods of storage in the yard are described. Wood preservatives giving a temporary protection of logs are listed.

The important role that fungi play in bringing about decay of wood has been recognized. The loss from decay in standing trees is mainly due to heart rot and to a less extent to sap rot while after conversion, much timber in transit, storage and service is lowered in value by decay and stain, thus necessitating an increased annual cut for replacement. A considerable proportion of this loss is preventable. Prevention of heart rot in standing trees comes under tree pathology and is outside the scope of this article which is intended to give methods of recognizing causes of decay and sap stain and their effects on wood and to lay down brief and specific directions for minimizing losses from sap stain and decay from the time a tree is felled till the timber is finally put to service. It is felt that an insight into these problems will help our foresters and timber merchants to handle timbers safely without incurring serious losses.

CAUSE OF DECAY

Decay of wood is caused by the action of wood destroying fungi. Fungi are lower plants in which the vegetative body known as the mycelium consists usually of much branched filamentous threads called hyphæ. The plants are devoid of chlorophyll – a colouring matter which imparts green colour to aerial parts of green plants particularly the leaves. The green plants absorb carbon dioxide from the atmosphere and water from the soil and synthesise them into simple sugars in the green cells containing chlorophyll in the presence of sunlight which supplies energy during the process. In the absence of chlorophyll, the fungi are unable to manufacture their food. The mycelium grows into the wood and other substrata and secures prepared food for the fungus.

Reproduction in fungi is effected by means of spores, microscopic in size, formed on various types of fruiting structures, which in the decay fungi are of the form of large, crusty, shelving or stalked sporophores (Pl. I, Fig. 1 ; Pl. II, Figs. 4 and 5). These are formed on the surface of the host after the fungi have developed within the wood for a considerable period. In sap stain fungi, the fruiting structures are minute and are usually discernible with the help of a hand lens. The spores are discharged from the fruiting bodies and under suitable environmental conditions may lodge on wood and cause infection. The infection may be direct through the exposed wood or indirect by being carried through the bark by bark beetles or wood boring beetles. Fungi causing sap stain usually infect the wood by the latter method.

FACTORS AFFECTING INFECTION OF WOOD BY FUNGI

When a fungal spore lodges on the surface of the wood, a prerequisite to penetration is that germination should take place, for which suitable environmental conditions must be present. These are the presence of oxygen, moisture and temperature within a certain range. Oxygen is always available to the germinating spore. The temperature at which most fungi germinate is in the wide range of 40°–85°F. These two factors are, therefore, of minor importance. Moisture is the controlling factor and spores can only germinate in free water in the form of rain, dew, etc., or in an atmosphere of high relative humidity (90–100%). Since a germinated spore cannot withstand desiccation, this moist condition must last for some time till the fungus has established itself within the substratum. The critical stage is then over and the fungus is less exposed to risk of drying. Infections by fungi are, therefore, common during wet weather and rare in the dry season.

GROWTH REQUIREMENTS OF WOOD DESTROYING FUNGI

The wood destroying fungi obtain food from cellulose, lignin, pentosans and other chemical components of the wood. The fungi are rather selective in their food requirements, some utilize the lignin leaving the cellulose more or less unaffected while others take in the cellulose and associated pentosans and leave the lignin intact. The two groups of fungi are respectively known as 'white rotters' and 'brown rotters'.

Inside the wood, the fungi require an optimum concentration of air and moisture for their growth. Air (oxygen) must be present in the wood for the fungi to respire. Insufficient air acts as a limiting factor and if the air is removed by saturation of the wood with water, the fungus dies. Likewise the fungi cannot grow if the moisture content of the wood is below 20 per cent based on oven-dry weight. If, however, infected wood is air-dried, the fungus does not die in the wood but its active growth ceases. The fungus may remain dormant for several years if the wood is kept dry but under moist conditions, the fungus may revive again and continue its growth in the wood.

With respect to temperature within the wood, wood destroying fungi make their optimum growth between 60° to 90°F. Their activity decreases at temperatures below or above this range and at temperatures near the freezing point and at about 110°F. and above, the fungi cease to grow in the wood.

It is thus evident that the air-moisture balance in the wood and the temperature are the important factors controlling the progress of decay in the wood. These factors change with the change in the environmental conditions. Thus in most parts of Northern India, the fungi remain inactive during winter between December – February when the air is cold and dry. Fungus activity begins from March or April onwards and reaches its peak between June-July to September–October when the hot season coincides with the monsoon rains, both the conditions being very favourable to the growth of fungi. In Central and South India, a real winter

is absent and the fungi remain active almost throughout the year though their activity is greatest between June and October.

GROWTH REQUIREMENTS OF SAP STAIN FUNGI

The growth requirements of sap stain fungi are similar to those of wood destroying fungi except in so far as the nature of food required by them is concerned. The fungi causing stain feed upon the cell contents rather than upon the cell walls and hence the attack is limited to sapwood which contains plenty of food in the form of starch and other cell inclusions. Stain fungi rarely, if at all, attack the heartwood which does not contain any food materials inside the cell cavities.

EFFECTS OF DECAY ON WOOD

Since the wood destroying fungi feed upon the cell walls, the strength of the decayed wood is gradually reduced. Early stages of decay may sometimes be attended with discolouration in the wood. It is difficult to diagnose decay at this stage except where the change of colour in the wood is striking. In the late stages, in the case of white rots, the decayed wood may be reduced to a white spongy or fibrous mass or to white pockets of varying sizes separated by areas of comparatively firm though infected wood (Pl. I, Fig. 2). The decayed wood may throw off splinters if it is raised by the point of a knife. Presence of brown to black lines (zone lines) is a common symptom of decayed wood. In brown rots, the decayed wood becomes brown and tends to break off in cuboidal blocks (Pl. I, Fig. 3) which easily become powdery under pressure. Sound wood should always be used for purposes where strength is the principal consideration. Infected timbers are sometimes used but the distribution, amount and type of rot in the wood are to be taken into account in calculating the mechanical strength to be expected from them. Such timbers should not, however, be used for purposes where sound wood is required or where conditions are such as to stimulate further development of fungi during service.

EFFECTS OF SAP STAIN ON WOOD

These fungi produce a discolouration in the sapwood. Blueing is the most common form of stain though the wood may take other hues like brown and grey. Since the cell walls are not attacked, most strength properties and the durability of the wood are not affected. Such wood can thus be used for rough purposes but is objectionable to timber merchants where colour is a principal consideration as for example in making furnitures, match sticks, etc.

DISTRIBUTION OF DECAY AND STAIN FUNGI IN WOOD

Fungi causing decay either attack the sapwood or the heartwood though the fungi on the sapwood may pass on to the heartwood and *vice versa*. Sap stain fungi, as already pointed out, are confined to the sapwood.

The progress of decay in the wood is considerably slower than that of sap stain. In the case of the latter, the wood can be completely blued within a few weeks under favourable conditions. The spread of decay and stain fungi is rapid along the length of the wood in the longitudinal direction of the grain and slow along the cross section of the wood in the transverse direction of the grain.

RESISTANCE OF TIMBERS TO DECAY

Fungi differ in their ability to decay wood and conversely timbers vary greatly in their resistance to fungal decay, termites, borers, etc. Teak, sal, bijasal, Indian Rosewood, *shisham* and deodar are some of the durable timbers ; *siris*, chaplash, jack, *jamun*, *babul*, *haldu*, *toon*, ebony, *hollong*, gurjan, blue pine and *chir* are some of the moderately durable timbers while

semul, salai and fir are a few of the common perishable Indian timbers. For a detailed list, the readers are referred to an article by Narayanamurti (1951).

IDENTIFICATION OF DECAY AND STAIN FUNGI

It is easy to identify the organism causing decay or stain when the fruiting structure of the fungus is present on the host. In many cases, however, the fruit body is absent. Rot, in the majority of cases, is not sufficiently characteristic for diagnosing the causal organism with certainty. Such fungi when grown in pure culture produce characters sufficiently distinctive to permit the species to be recognized provided a large number of authentic cultures from sporophores are available for comparison. The characters of the fungi in culture which are considered may be macroscopic like texture, colour, rate of growth, formation of fruit body, etc., or microscopic. The nature of the decay a fungus will produce may be found in the laboratory by oxidase reactions when a 'white rotter', grown on malt agar containing gallic or tannic acids, produces a dark diffusion zone underneath the fungus mat while a 'brown rotter' gives no such reaction. There are other tests to distinguish white rotters from brown rotters. By growing the unknown fungus on sterile wood blocks for some months, the detailed character of the rots, both macroscopic and microscopic, can be observed. The virulence of the organism in destroying wood can also be determined by such decay tests from the loss of weight of the wood blocks based on oven-dry weights taken before and after the test.

Identification of the organism causing decay has great practical importance. *Fomes pini* (= *Trametes pini*), in its initial stages of decay, does not reduce the strength properties of the wood to such an extent as to prevent its use for purposes where sound wood is prescribed. Even the rotted wood in advanced stages of attack can be used for purposes where strength is not a principal consideration since *F. pini* does not work in the wood, once it is converted, so that there is no risk of the timber deteriorating in service. Such studies thus avoid any unnecessary rejection of timber. Once the identity of fungus causing a rot is established, the source and origin of infection can be determined. For instance, a huge consignment of Sitka spruce sleepers from Canada was found to be heavily infected when it reached Bombay Port in 1943. Isolations from the rotted wood yielded *Poria monticola* – a fungus so far known to be present in North America only. It was, therefore, concluded, that the wood was infected before shipment and during its long journey, in the hold of the ship, where temperature and humidity conditions were particularly favourable for the growth of the fungus, the rate of decay became greater, resulting in a considerable loss of timber. *Poria monticola* has since been found to attack *chir* – one of our native conifers (Pl. I, Fig. 3).

PROTECTION OF A TREE AFTER FELLING

1. *Time of felling*—Natural protection to a tree is afforded by the bark. When a tree is felled, spores may lodge on cut ends or bruised portions of the bark, grow into the wood and set up decay and stain. Felling should preferably be done in winter, when the fungus activity is on the decline. Summer-felled wood is immediately exposed to infection by fungi which are very active during the summer.

2. *Transport of logs*—Many of our forests in India are situated in inaccessible areas so that the transport of logs is a problem. The methods of extraction of timber are in some cases so primitive that it takes a considerable period in bringing the logs to saw-mills. Such primitive methods like hand sawing, bullock-cart extraction, should be replaced by mechanical contrivances devised and modified to suit local conditions. The risk of timber being attacked by fungi becomes considerably less, if the timber is rapidly transported to saw-mills and converted. The area of felling operation should be such that the felled trees can be extracted soon. Such logs should be sawn into smaller portions. This helps in drying as well as facilitating transport. Barking should always be preferred. In some cases, for example, during transport

of timbers down the hills by the 'dry slide' or 'wet slide' methods and finally through the rivers in rafts, it is necessary to saw the logs into sleepers after barking. Barking decreases the susceptibility of the wood to fungus attack since it hastens the escape of moisture from the wood. Logs left in the forests with the bark may be attacked by fungi, which infect the wood, through cracks in the bark (Pl. I, Fig. 1). Such logs are also liable to attack by bark beetles.

No preservative treatment is necessary for durable or moderately resistant timbers if they reach the saw-mills within a few months after felling. With perishable timbers, however, it is advisable to treat the logs after barking with a preservative within 48 hours after felling. Delay in treatment of wood may result in their infection by fungi which will be difficult to eradicate in later periods.

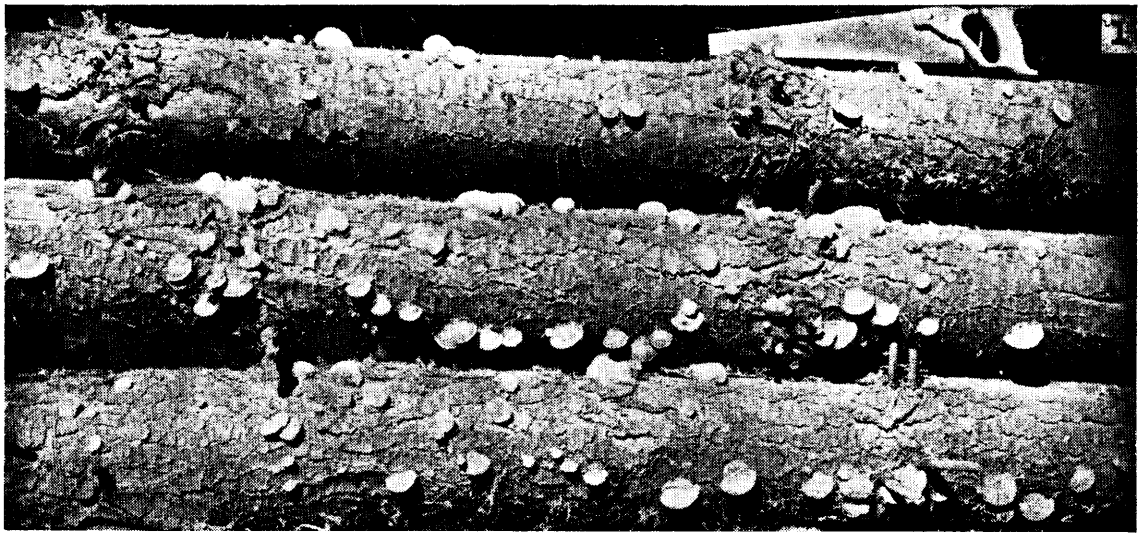
Logs may be transported overland or through water. During water transport, the logs may be held up in jams and the longer the drive through water, the greater the risk of timber to decay. In a recent instance, a heavy consignment of timber consisting of soft hardwood timbers, mostly *semul*, was indented for by the Western India Match Co. Ltd., Calcutta, from Assam forests. The timbers were built in rafts and were floated down the river Brahmaputra. The logs remained in water for several months. Decay set in on the exposed portions of the logs above the water line and by the time they reached Calcutta, timber worth two hundred thousand rupees were lost for all practical purposes. An effective method of protecting such timber is to debark the logs and spray them with a 'fixed' type of preservative within 48 hours after felling. The treated logs should be left in the forest floor for a few days for the preservative to get fixed and then transported. In another instance, a consignment of fir obtained from the Himalayas by M/s. Bal Gopal Das & Sons, timber merchants, Dehra Dun, for manufacture of packing boxes was found to be severely affected by decay fungi. The timber was apparently left for a long time in the forests after conversion into planks without any treatment. Infection took place in the felling coupes since the fungi* isolated from the rotted wood all belong to the temperate region of the Himalayas.

3. *Storage of logs* – (i) *in forests*—Though it is desirable to remove the logs from the forest soon after they are felled, it may not be possible to remove them all at once and logs may have to be left behind for sometime. Such left-over logs should invariably be debarked to prevent the attack of bark beetles and the accompanying stain, sprayed with a preservative and stored under proper sanitary conditions in such a way that air-seasoning of the logs is also achieved. They may be left over with greater safety during the winter months than during the summer.

(ii) *in timber yard*—After the logs have reached the timber yard, they should be stored if sawing up is delayed. The logs should be barked since the process hastens the escape of moisture from the wood and thus decreases their susceptibility to decay. Storage of logs under water in log ponds is ideal wherever this method is available. This also prevents end splitting of logs. Logs should be entirely submerged or else the portion floating above water may be subjected to decay. One method of achieving this is to have a series of girders above the logs across the log pond and filling the latter above the level of the girders. When this method is not available the logs should be stored dry under sheds where they are unable to pick up moisture. The logs in such cases will be immune to attack by fungus. Logs exposed to damp situations absorb moisture and become susceptible to fungus attack.

A spray or brush treatment of logs with a preservative is advisable particularly in the case of perishable and soft hardwood timbers to be stored for sometime. Such treatment may not be necessary for resistant timbers stored for a short duration, since the infection, if it occurs at all, will be superficial and removed during the planing of the wood.

* Three fungi *Lenzites subferruginea*, *L. sepiaria* and *Fomes roseus*, all causing brown rots, were isolated from decayed wood.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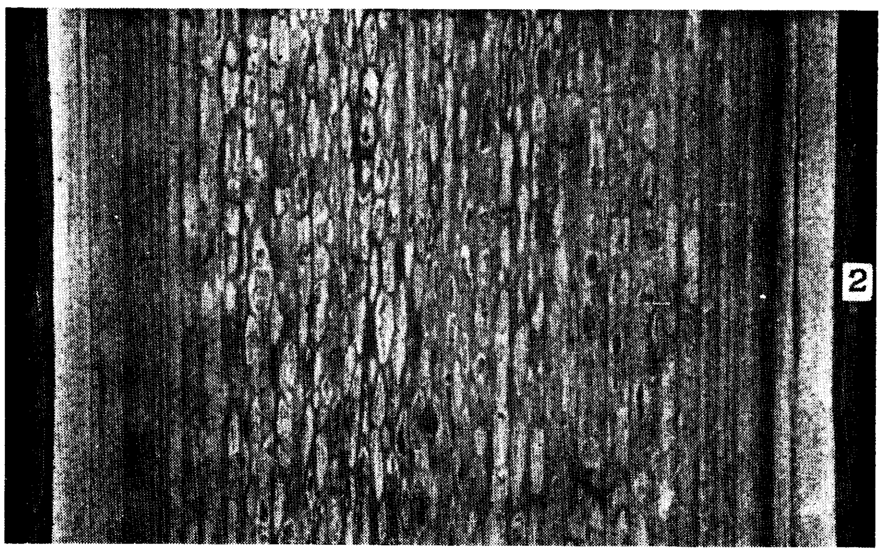
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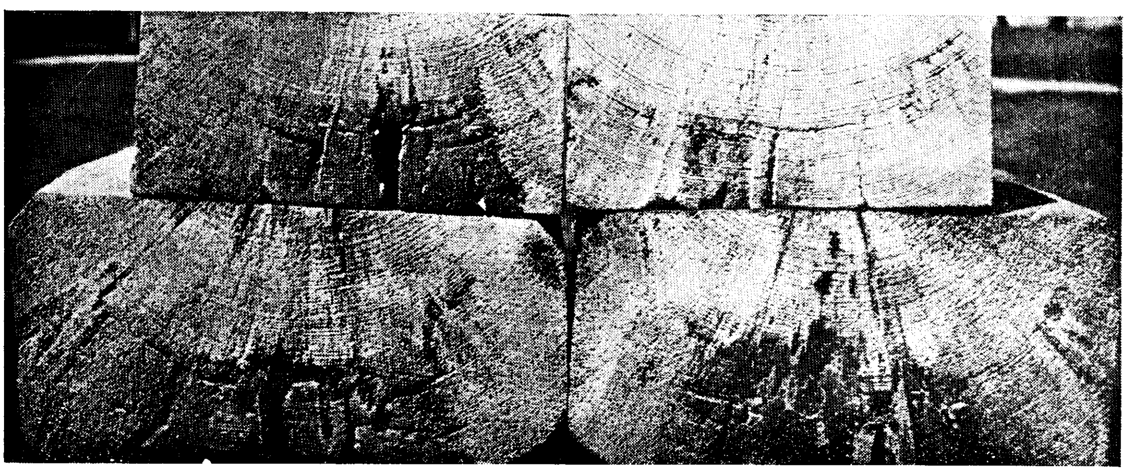

PLATE II

The storage yard should be on a well-drained ground, hygienically clean, free from weeds and raised off the ground either on creosoted timbers or on concrete structures about a foot high. The logs should be stored properly so that there is a circulation of air through the innermost logs in the pile. If the logs are stacked in such a way that the movement of air through the stack is slackened, there is an accumulation of moisture in the innermost layers in the pile creating favourable conditions for the growth of fungi. Practical methods of stacking timbers for seasoning have been described by Kapur (1934).

Logs should never be stored in a closed room. During April, 1949 some *chir* sleepers were stacked in a closed godown in New Forest. By the end of September, 1949, most of the *chir* sleepers were severely attacked by a fungus, *Poria monticola*, which caused a brown-rot in wood (Pl. I, Fig. 3). The rot is loosely termed as a dry-rot but this term is strictly applied to decay in timber used for constructional purposes. Dry-rot is a brown-rot which develops as a result of dampness. The *chir* sleepers were stored in a closed room during the rains when the atmosphere was hot and humid which accelerated the growth of the fungus in the wood.

Each lot of logs must be kept separately and used in sequence according to the length of time they are held in storage. One lot of logs should not be piled on another which arrived earlier since the top layers may be utilized leaving the bottom ones untouched. Decayed logs should not be kept in the timber yard for long but converted immediately. Decayed logs left over in the timber yard often produce fruiting bodies of fungi which develop particularly during rains. These fruiting bodies help in the spread of the fungus to sound logs. In cases where such fruiting bodies develop, they should be collected and destroyed.

The maxim 'Prevention is better than cure' should be remembered in preventing decay and stain of timber. Every care should be taken to avoid infection by a fungus since it is difficult to eradicate it once infection has occurred. In such cases, surface treatment with a preservative is not effective while treatment under pressure takes the preservative a few inches from the wood surface and may fail to kill the fungus if the latter has penetrated deep into the wood. In such cases a wet heat treatment at 140°–150°F. for a time depending on the thickness of the wood is required to kill the fungus within the wood since the temperature at which fungi are usually killed (thermal death point) is about 120°–130°F. Such treatments can be adopted in seasoning kilns.

WOOD PRESERVATIVES IN PROTECTING LOGS BEFORE REACHING TIMBER YARD

Treatment of timber during its various stages in service life with more permanent wood preservatives, which require the wood to be impregnated, is beyond the scope of the present article. Temporary protection of the green wood during its transit to timber yards and subsequent storage is, however, necessary and this can be effectively done by spray or dip treatment of barked logs with chemicals toxic to fungi. Chemicals that have been found to retard both decay and sap stain (Hartley, 1945) are listed below :—

Chemical	*Pounds in 100 gallons of water*
Lignasan (Contains ethyl mercuric phosphate) ..	2
Dowicide H (Sodium tetrachlorophenate)	7
Santobrite or Dowicide G (Sodium pentachlorophenate)	7
Permatox 1OS	10
A mixture made of	
Santobrite or Dowicide G	3
Powdered borax	12
A mixture made of	
Santobrite or Dowicide G	2
Lignasan	$\frac{3}{4}$
Powdered borax	8

The preservatives listed above are water soluble and hence cannot be used in cases where the logs or sleepers are to be floated down rivers after treatment since the preservatives will be leached away. In such instances 'fixed' type of preservatives like zinc meta-arsenite, Wolman salts, Ascu which are more resistant to leaching are recommended.

Sincere thanks are due to Mr. C. R. Ranganathan, President, Forest Research Institute and Colleges for valuable criticism and to Dr. K. Bagchee, Mycologist, for making available some informations and for permission to use some of the photographs used for illustrating this article.

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EXPLANATION OF PLATES

PLATE I

FIG. 1.—Fruit bodies of *Lenzites subferruginea* growing through crevices in the bark of deodar (*Cedrus deodara*). The logs were left for sometime after felling in the forests and were attacked by the fungus (x 1/12).

FIG. 2.—White pocket rot in blue pine (*Pinus excelsa*) caused by *Fomes pini* (Nat. size).

FIG. 3.—Brown cuboidal rot in *chir* (*Pinus longifolia*) sleepers attacked by *Poria monticola*. The *chir* sleepers were stored in a closed godown without ventilation and were severely decayed by the fungus in a few months (x 2/7).

PLATE II

FIG. 4.—Fruit bodies of *Lenzites striata* on barked poles of *sal* (*Shorea robusta*) stored in a godown (x approx. 1/12).

FIG. 5.—Fruit bodies of *Trametes meyeni* on cut end of *semul* (*Bombax malabaricum*). The logs were kept in a log pond partly submerged in water. The fungus developed on exposed portion of the logs out of water (x 1/4).

CULTIVATION OF BAT WILLOWS IN KULU

BY D. P. SINGH
Deputy Conservator of Forests, Hoshiarpur

SUMMARY

Preliminary trials on cultivation of English and Kashmir bat willows (both obtained in the form of cuttings from Kashmir) have given encouraging results in Kulu forest division. The problem is being pursued with full zeal and vigour and if the success attained so far is maintained in coming years, the future of sports' industry in the Punjab is assured.

INTRODUCTION

The idea of willow cultivation in the Punjab, for sports industry, was conceived as early as nineties of the last century but it remained in the background for a long time, because of transport difficulties from areas where it could be planted. In the thirties of this century the Government of Kashmir placed an embargo on the export of Kashmir willows – *S. fragilis* and *S. babylonica*, thus cutting off Sialkot (a sports industrial town of the Punjab) from its only source of supply and this led to fresh enquiries for something to take their place which could be grown in the Punjab. Some specimen logs of indigenous willow – *S. wallichiana* collected from 2/20 Patalsu near Manali were sent from Kulu to Forest Research Institute, Dehra Dun for tests in August, 1940 but unfortunately the results were not received probably because of the pre-occupation of the Utilization Branch in the more important war works. Some specimens were also sent to Sialkot from Kangra but the report received was not encouraging.

Then came partition of the Punjab and like many other things, sports industry also received a serious set back. The acute supply problem of bat willows, therefore, attracted the attention of the Government and the question of its cultivation thus received a fresh impetus.

TRIALS IN KULU

Attempts to propagate the much needed willow (both English and Kashmir species) were made at Manali Nursery in Kulu valley. During 1949 about 600 branch cuttings were imported from Srinagar which gave 95% success with 5 feet average and 9 feet maximum height during the first growth season under nursery conditions. English willows gave 87% of success.

In order to find out how the bat willows would pass through forest conditions the following number of cuttings obtained from the nursery at Manali was planted in the forests during 1949 rainy season.

Area where planted	English bat willow cuttings		Kashmir bat willow cuttings	
	No. planted	No. surviving in July, 1950	No. planted	No. surviving in July, 1950
Between 4,500 feet and 6,500 feet altitude				
1. R/2 Monalgahr	..	..	35	33
2. R/3 Dana Bihal	24	23	..	..
3. 1/6 Aleobihal C. II	20	19	..	..
4. Patlikuhl compound	..	..	40	39
5. Kala Jairu Bihal	..	..	14	8
Between 4,000 feet and 4,500 feet altitude				
6. Seo Bagh Bihal	..	..	7	..
7. Tharman Bihal	..	..	7	..
Total	44	42	103	80

It was observed that above 4,500 feet altitude both the English and Kashmir bat willows did very well but below 4,500 feet the trials gave a rather disappointing result. It was, therefore, decided to drop the idea of planting bat willows below 4,500 feet (at least until the technique of bat willow cultivation in Kulu Valley is well established) and to continue with willow cultivation only between 4,500–6,500 feet altitude. As a result of this decision willow plantings were carried out in Kulu valley only above 4,500 feet during rains of 1950 and over 400 cuttings English and Kashmir willows were planted. Little planting of bat willows was, however, carried out during 1951 as no supplies of cuttings were received from Kashmir and it was decided to utilize the balance stock of plants in Manali nursery for multiplication and meeting with our requirements of cuttings in future years. In the Tirthan valley of Seraj Forest Division 140 English and 180 Kashmir bat willow cuttings were planted during July, 1950 and although the success was not so encouraging as in Kulu valley yet about 200 plants are still surviving.

During 1952 (February–March) we carried out extensive plantings of willows from cuttings raised from our own stock in the forest and the progress up-to-date (including plants of 1949 and 1950 is tabulated below for Kulu Forest Division.

Area where planted	English bat willow cuttings		Kashmir bat willow cuttings	
	No. planted	No. surviving up to 31–3–52	No. planted	No. surviving up to 31–3–52
A. Upper Kulu Range				
1. R/2 Monalgahr	35	27	..	..
2. R/3 Dana Bihal	..	..	24	15
3. 1/6 Aleo Bihal C. I and C. II ..	55	24	170	142
4. 1/9 Brunudhar C. I and C. II	7	6	8	8
5. 1/5 Somban C. III ..	..	..	22	22
6. 1/6 Batahir Bihal C. II ..	..	..	200	200
7. Manali III	..	..	58	58
8. Jagatsukh III	20	18	..	..
9. Patlikuhl Depot compound ..	..	..	85	69
Total	117	75	567	514

Area where planted	English bat willow cuttings		Kashmir bat willow cuttings	
	No. planted	No. survivig up to 31–3–52	No. planted	No. surviving up to 31–3–52
B. Soil Conservation Unit				
10. Kala Jairu Bihal	..	..	14	8
11. Shirar Bihal ..	..	..	100	100
12. Katrain Bihal	32	29	..	..
13. Patlikuhl Bihal	30	23	..	..
14. Manali Bihal	..	..	115	85
15. Bashisht Bihal	72	41	40	30
Total	134	93	269	223
GRAND TOTAL	251	168	836	737

All the plants that have survived are putting up excellent growth so much so that most of the cuttings planted during 1949 are now about 20 feet high and have put in excellent increment.

Besides the above noted number of cuttings planted in the forest the following number has been put in the nurseries ; the stock of cuttings have been obtained from branch cuttings of the plantings carried out in 1949 and 1950.

	Kashmir Willow (Number)
Patlikuhl Depot	110
Kala Jairu ..	250
Patlikuhl ..	500

While it had been decided to depend upon our own stock of plants special efforts to obtain fresh supplies of cuttings were made during 1951 and Kashmir Forest Department was again approached for sending as many of English and Kashmir willow cuttings as possible. With the kindness and co-operation of the Chief Conservator of Forests, Jammu and Kashmir and the keen interest of the Conservator of Forests, North Circle, the writer was able to obtain 840 (English 370 and Kashmir 470) cuttings from Kashmir during March, 1952. The cuttings were carried by air from Srinagar to Amritsar wherefrom the same were brought to Kulu by lorry. These have all been planted in nurseries at *Manali* and *Patlikuhl* so that in future we shall be able to meet our own requirement of cuttings.

SILVICULTURAL AND OTHER REQUIREMENTS

It may not be out of place here to mention briefly the silvicultural and other requirements of bat willows for the general interest and to serve as a useful guide for places where similar operations may be undertaken in future.

(*a*) *Soil and Water Requirements*—Good soil and water conditions are the pre-requisite for the healthy growth of willow and to produce good timber. Willows thrive best in deep well-drained and permeable soil along the banks of running streams, from 2½ feet to 4 feet above the normal water-level; occasional flooding does not matter provided the flood water-drains off quickly. Broadly speaking well-drained, moisture retaining loamy soils are the best. Hard clay soils are unsatisfactory owing to defective drainage and also because they prevent penetration of roots. Sands and gravels tend to cause failure owing to lack of retentive power of moisture and consequent liability to drought. Good drainage in the case of willow growing is synonymous with good aeration and hence water-logged and marshy soils are inimical to its growth. Reclaimed swampy soils which are rich in alluvium and are subject to flooding are, however, quite suitable for their cultivation.

(*b*) *Climate*—Willows can grow over a wide range of climatic factors. In the Punjab willows are found right from sub-mountain regions of Himalayas extending to the inner arid zones of Lahaul at about 8,500 feet to 11,000 feet above sea-level. But from the point of view of cultivation of cricket bat willow excessive humidity, wind, periodic droughts, frost and low altitude are the chief adverse meteorological factors. Encouraging results have been obtained above 4,500 feet but below 6,500 feet altitude in the Kulu valley.

It has been observed that willow is a strong light demander. Its growth is stunted and sickly under shade as has been noticed in R/2 Monalgahr and R/3 Dana Bihal while under adequate over head light plants put on good helthy growth.

(*c*) *Propagation*—The propagation of willows is generally carried out by means of sets or cuttings of various sizes. The practice in Kulu so far has been to plant about 12 inches long cuttings in the field and this has given good results. These cuttings were obtained either from nursery (out of shoots which were given out by cuttings obtained from Kashmir) or from branches of trees and the operation of planting was much the same as practiced for other species which are grown by shoot cuttings. It is, however, felt that by this system it is not convenient and practicable to raise bat timber of required specification as tending operations particularly prunning have to be carried out in scattered areas. Because of this and also because of the expense and difficulty involved in procuring cuttings either from Kashmir or England it is considered desirable to revise the system to suit our own requirements. In future cuttings obtaind from outside should be put in nursery during February–March as has been the practice so far. These will be allowed to grow so as to obtain maximum number of shoots, which will be cut in the following year in about 12 inches size and planted in large size willow nurseries at a distance of 2 × 2 feet during February–March. The cuttings will be buried into the soil leaving about an inch above the surface. During spring and summer these cuttings will produce number of shoots frequently arising in groups of 2–4. When shoots are about 3 inches long the number of shoots per cutting will be reduced to six under proper espacement. By about the beginning of rains the shoots will have grown up to 1 foot and then only 2 shoots will be finally retained with due regard to symmetry, size of shoot, position of buds, etc. The shoots will be kept under close observation during monsoon and whenever double leaders arise such should be cut as close to stem as is safe. When any damage to leading shoot occurs uppermost lateral shoot should be retained. The kink or bend that is caused by this may be over-come by tying a piece of wood as a splice. In the following winter, i.e., December all side shoots should be prunned close to the stem and only leading shoot be retained. During the 2nd year's growth the lateral shoots should be allowed to grow freely unless interferring with the leader. Dormant buds that may arise on first year's growth should be rubbed with hand as soon as noticed. It should be seen that the stem is clear of all shoots and buds up to a height of 10 feet and if considered necessary lateral shoots may be removed. At the end of two years under favourable conditions of growth the shoots will be

about 10–12 feet long and about 1–1½ inches in diameter and this will provide 3 bat lengths. Where such lengths are not obtained within 2 years the shoots should be allowed to remain until following year to come up to the requirements.

(*d*) *Planting technique*—Unrooted sets may be planted in 2–2½ feet deep holes obtained by means of crow-bars, but for rooted sets a sufficiently wide hole should be dug with a spade to take the roots when spread out and can later on be filled with as fine and good soil as can be found. The depth of the hole should be such that the collar ramains flush with ground surface after planting. Care should be taken to secure close soil contact with all the parts of the stem. The main point to ensure is a minimum movement of the buried parts of the stem so that the young roots are not broken by wind actions on the upper parts of the plant.

Willows grow well when given plenty of space for their development. Dense plantation of willow produces worthless timber and the trees in them are particularly liable to become diseased. The best distance for planting in single rows, i.e., along both the banks of streams, is about 30–35 feet with plants alternating.

(*e*) *Planting seasons*—Planting of willow in the fields is generally carried out during late winter, i.e., from 15th January to 15th March. Monsoon plantings during early July after first shower of rain has also proved successful. In Kulu Forest Division monsoon plantings were tried during first 2 years and have given very encouraging results. The late winter plantings were tried during 1952 and results have been excellent.

(*f*) *Protection*—Protection is a very necessary item of propagation of the species.

Until last year willow was not declared as a reserved tree under the Indian Forest Act and was, therefore, not protected against damage by the people, who could cut or lop it without permission. In order to propagate willows in the valley it was considered absolutely necessary to secure adequate legal protection to the species. Accordingly a reference was made to Government and *all* willows (*Salix* spp.) were reserved, *vide* Notification No. 4909-D-51/4680 Addendum dated 10th September, 1951. This, combined with effective enforcement will facilitate protection against damage by man and animals.

Willows are also liable to be damaged by wind and snow. Damage by wind is likely to be heavy in early period of the crop while snow may occur in unthinned young and middle-aged crops. Proper tending and care can minimize such damage.

The most serious damage to which the Kashmir willows are liable is by defoliator, *Lymantria obfuscata* (*Lymantriidee*). Similarly certain damage may also occur due to insect pest San Joe Scale. Fortunately Kulu valley is safe from these two insect pests so far and great care should be taken to see that willow cuttings are properly treated before despatch by Kashmir or other suppliers.

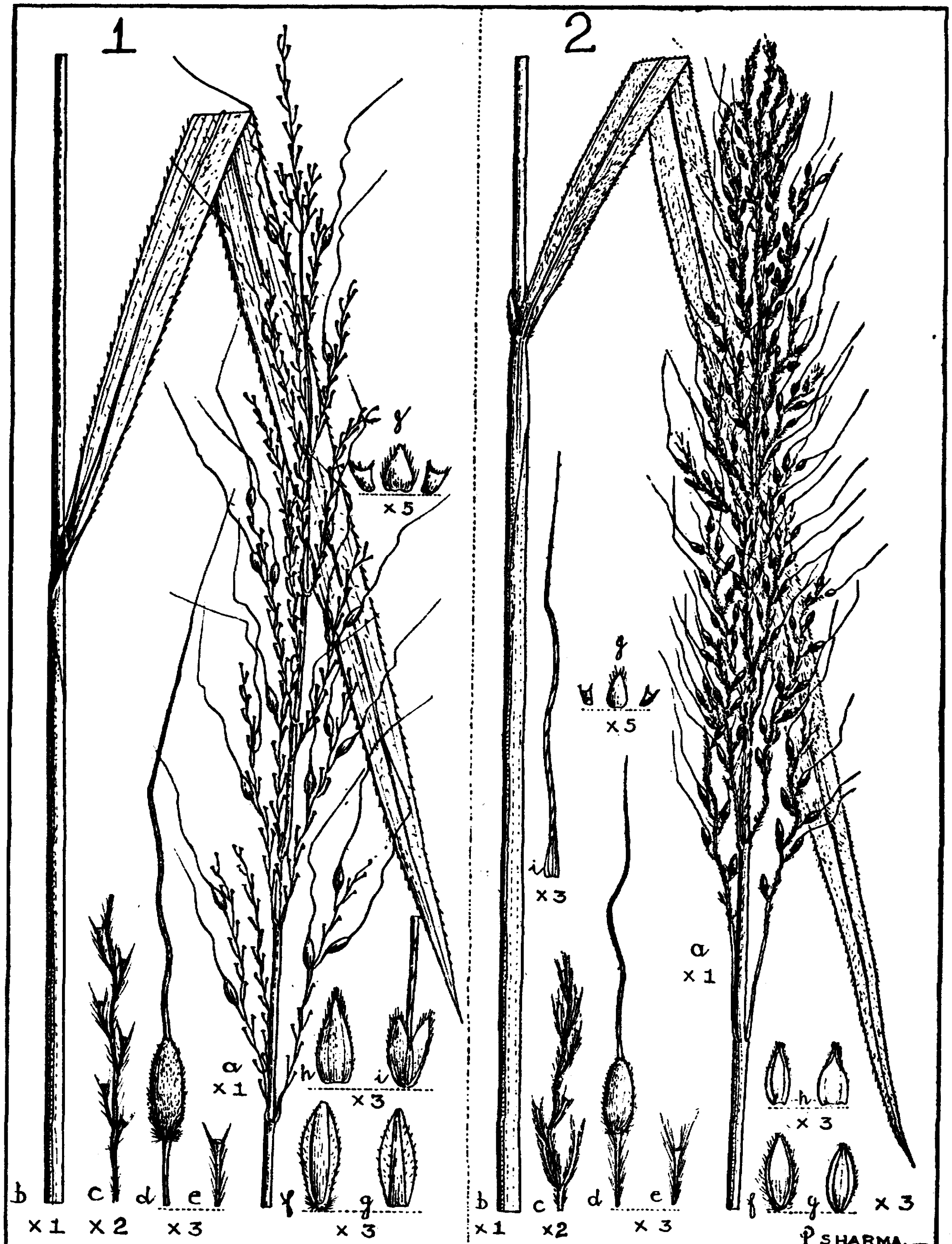
(*g*) *Tending*—Up to the formation of rough bark dormant buds may develop on the commercial bole and all such soft shoots and buds must be rubbed by hand whenever they appear in order to produce timber free from knots up to a height of 8–10 feet. Neglect of this makes the timber of little or no value for cricket bats. When double leaders arise one of these should be cut away carefully as close to the junction as is safe.

FUTURE

Cricket bat timber is obtained only from 2 species of *Salix*, viz., *Salix fragilis* and *Salix alba* and from some of the hybrids between them, viz., *Salix viridis*, etc. The blue willow, *Salix alba* var : *cœrulea*, however, furnishes the best cricket bat timber and this variety alone should be propagated for bat industry. So far we have obtained cuttings of this variety

from Kashmir but efforts are being made to get the same from England. The best strain in the variety is from Essex and is generally grown in East Anglia. Besides giving a fresh impetus to the cultivation of English bat willows, the present efforts to propagate Kashmir bat willows should also continue for augmenting supplies for manufacturing cheap bats and for meeting demands of other industries.

Willow timber is soft, light in weight, fairly easily cleft and is able to resist considerable shock without splintering. Willow timber is capable of taking a good polish, is without objectionable odour or tint, is free from resinous matter and is straight grained. Because of these qualities willow timber is valuable and can be used for many industrial purposes. Willow timber makes good brake block for vehicles fitted with steel wheels or tyres and is suitable for crates, barrels, boxes, honeycomb frames and containers for foodstuff. It is well suited for brake drums and in other situations where heat may be generated by friction. Because of its veneering properties it can be used for the manufacture of veneer packages. It can also find its use in match splints, pencil wood and pen-holders. Cultivation of bat willows has, therefore, wide field and bright future in the state and deserves all the encouragement and adequate investment.


1
2
a ×1
b ×1
c ×2
d e ×3
f g ×3
g ×5
h i ×3
i ×3
f g ×3
h ×3
P. SHARMA

INDIAN SPECIES OF *CLEISTACHNE* BENTH.

BY M. B. RAIZADA AND R. C. BHARADWAJA
Forest Research Institute, Dehra Dun

The genus *Cleistachne* Benth. of the family *Gramineæ* was established by Bentham in the year 1882. Only one species *C. sorghoides* Benth. was known in those days. This species occurs in tropical Africa and is the type of the genus.

In the year 1896 Hook.f. described another species, *C. stocksii* Hook.f. in his Flora of Br. Ind. VII (1896) 162, collected by J. E. Stocks from the Malabar Coast. This was the only Indian species of *Cleistachne* known up to the present day and it is endemic in India.

Recently Mooney sent us a specimen of *Cleistachne* collected from Khairagarh State, C.P. (Madhya Pradesh) which did not match with the Indian species in our collection. It was consequently sent to Kew for opinion where it has been identified by Dr. Bor as *C. sorghoides* Benth. This is, therefore, the first record of this species for India.

In the present paper a detailed account of the genus and its two Indian species is given together with a key.

CLEISTACHNE BENTH.

Cleistachne Benth. in Hook. Ic. Pl. t. 1379 (1882), in Benth. et. Hook.f. Gen. Pl. III (1883) 1120 ; Hack. in E.P.I. Aufl. II 2 (1887) 30, Monogr. Androp. (1889) 652 ; Hook.f. Fl. Br. Ind. VII (1896) 162 ; Stapf. in Fl. Trop. Afr. IX (1917) 154 ; Pilger in Die Nat. Pflanzenfam. Band 14e (1940) 142.

The word *Cleistachne* is derived from *Kleistos*, hidden and *achne*, chaff, husk, referring to the gl. I and II completely enclosing the gl. III and IV.

Annual or perennial, coarse grasses. Culms tall. Leaf-blades long, flat, with a stout midrib.

Panicle narrow, more or less contracted, greyish or fulvously hairy. Spikelets all alike, solitary, hermaphrodite, pedicelled, falling entire from the thickened tips of the pedicels, 1-flowered, lanceolate, slightly compressed on the back, awned ; gl. I and II equal, similar, margins involute, more or less coriaceous, delicately 7–9-nerved, muticous ; gl. III empty, hyaline, 2-nerved ; gl. IV hyaline 3-nerved, 2-dentate or entire, with a twisted flexuous awn from the sinus or tip ; palea minute, ciliate or 0 ; lodicules 2, broad-cuneate, sparingly ciliate ; stamens 3 ; stigmas laterally exserted, plumose ; grain oblong to obovoid-oblong very obtuse to truncate.

The genus contains three species distributed in tropical Africa and Peninsular India. It belongs to the tribe *Andropogoneæ* and sub-tribe *Sorginæ* (*Sorghastræ* of Stapf.). It is readily distinguished from the other members of the sub-tribe by the presence of solitary pedicelled spikelets.

KEY TO THE INDIAN SPECIES

Spikelets golden yellow ; gl. IV 2-fid .... 1. *C. sorghoides*

Spikelets dark brown ; gl. IV entire .... 2. *C. stocksii*

Cleistachne sorghoides Benth. in Hook. Ic. Pl. XIV. 60, t. 1379 (1882) ; Stapf. in Fl. Trop. Afr. IX (1917) 154.

Sorghoides means like *Sorghum*.

An annual grass. Culms simple or branched from the base, up to 3 m. high, sometimes rooting from the lowest nodes, glabrous. Leaf-blades linear tapering to a fine point, gradually narrowed towards the base, 25–60 cm. long and up to 1 ·2 cm. broad, flat, appressedly pubescent to hirsute with tubercled based hairs ; midrib prominent, stouter towards the base, rounded on the back, whitish, lateral nerves 4–6 on each side, fine ; margins scabrid to spinulously ciliate ; sheath-terete, the lowest at length loose, otherwise tight, more or less hirsute or glabrous, the lower prominently striated, glabrous at the nodes ; ligule firmly scarious, rounded, up to 7 mm. long, brown.

Panicle linear-oblong to oblong, up to 25 cm. long and 2 ·5–3 ·5 cm. wide, rather dense ; rhachis more or less grooved, scabrid to spinulously ciliate on the angles above or smooth below ; branches usually 2-nate, divided from the base ; the longest up to 7 ·5 cm. long, secondary branches often very few, hairy and often silky-villous at the thickned base ; pedicels filiform with thickened tips, up to 4 mm. long with hairs up to 2 ·5 mm. long. Spikelets oblong, up to 5 mm. long, straw-coloured in young stage, chestnut-brown at maturity, slightly glossy, densely greyish – pubescent, at length glabrescent on the back ; callus obscure, shortly bearded ; gl. I thinly coriaceous, minutely truncate, finely 5–7-nerved ; gl. II coriaceous, similar to the I ; gl. III hyaline, lanceolate, acute, over 4 mm. long, 2-nerved, ciliolate on margins ; gl. IV oblong or ovate-oblong, 3 mm. long or slightly more, ciliolate, finely 3-nerved below the awn, awn 2 ·5–3 ·5 cm. long, twisted up to the middle, the twisted part often flexuous or curved ; palea ciliolate ; lodicule ciliolate. Anthers 2 ·5 mm. long. Caryopsis 2 mm. long, brown.

"In the open grassy bamboo forest, Kangura, 1,800 ft., Khairagarh State, C.P., 6–11–1941, H. F. Mooney 1991".

Distribution : Tropical Africa.

Cleistachne stocksii Hook.f. in Fl. Br. Ind. VII (1896) 162 ; Fischer in Fl. Madras X (1934) 1708 ; Blatter & McCann, Bombay Grasses (1935) 64.

The species is named after J. E. Stocks (1822–54) of the Bombay Medical Staff.

Culms tall up to 120 cms. high, stout, simple or rarely branched, more or less glabrous ; nodes glabrous or slightly villous, sometimes rooting at the base. Leaf-blades linear, flat, 30–40 cm. long and 10–14 mm. wide, finely acuminate, gradually narrowing towards the base, hairy on both the surfaces, midrib prominent, stout ; margins slightly thickened, scabrid, spinulose, ciliolate ; sheath terete, ribbed, glabrous or with long hairs ; ligule up to 9 mm. long, coriaceous or chartaceous, glabrous or slightly hairy.

Panicle up to 22 cm. long, sub-erect, peduncle long, exserted, smooth, glabrous ; rhachis slender, grooved, rufous or golden hairy ; branches up to 6 cms. long, ciliate with rufous or golden hairs ; pedicels 2–3 ·5 mm. long, clavate, strigose with bright yellow hairs. Spikelets up to 4 mm. long, crowded, dark brown, covered with bright yellow hairs ; callus short ; gl. I lanceolate, narrowly truncate, dark brown, coriaceous, dorsally rufous or golden hairy, margins involute, obscurely nerved ; gl. II narrowly truncate, dark brown, coriaceous, dorsally rufous or golden hairy or glabrous, narrower than the I, margins involute ; gl. III hyaline, 2-nerved, tip hispid, margins infolded ; gl. IV entire, with a twisted awn, up to 3 cm., dilated at the base into a hyaline 3-nerved membrane embracing the minute palea ; palea ovate, obtuse ; lodicule minute, ciliolate.

"Silent valley, 5,000 ft. in grass land, Nov. 1938, Bor 8430".

It has also been collected from Konkan (Blatter and McCann) ; Malabar (Hooker. f.) ; Bababudan Hills (Law) and Travancore at Santhapara, 4,000 feet (Meebold).

Distribution : Peninsular India.

Explanation of the Plate

1. *Cleistachne sorghoides* Benth.
   (a) inflorescence (b) leaf (c) part of rhachis (d) spikelet (e) pedicel (f) glume I (g) glume II (h) glume III (i) glume IV (j) lodicules and palea.
2. *Cleistachne stocksii* Hook. f.
   (a) inflorescence (b) leaf (c) part of rhachis (d) spikelet (e) pedicel (f) glume I (g) glume II (h) glume III (i) glume IV (j) lodicules and palea.

STATEMENT OF WILD ANIMALS SHOT IN SOME OF THE

BY PUBLICITY AND LIAISON OFFICER,

All-India Serial No.	Species	Ajmer-Merwara	Assam	Bengal	Bihar	Bombay
1	2	3	4	5	6	7
1a	Tiger	1	56	10	3	..
1b	Tigress	..	8	4	..	..
2	Leopard or Panther	..	35	35	4	..
3	Wild cats (species to be given, if known)	..	16	8	1	..
4	Lynx	..	13	..	..	..
5	Hunting leopard or Cheetah	..	4	..	..	..
6	Hyena	..	..	..	..	..
7	Wolf	..	7	..	..	..
8	Wild dog	..	1	6	..	..
9	Martens	..	..	..	..	..
10	Ratel	..	..	..	..	..
11	Brown bear	..	1	..	2	..
12	Himalayan black bear	..	..	4	..	..
13	Malayan bear	..	..	..	..	..
14	Sloth bear	..	1	4	..	..
15	Wild elephant	..	16	..	1	..
16	Rhinoceros (species to be given)	..	..	..	..	..
17	Gaur or bison	..	..	..	..	..
18	Goyal or mithan	..	1	..	..	..
19	Banting or tsine	..	..	..	..	..
20	Wild buffalo	..	2	..	..	..
21	Urial or sharpu	..	..	..	..	..
22	Bharal or blue sheep	..	..	..	..	..
23	Ibex	..	..	..	..	..
24	Markhor	..	..	..	..	..
25	Tahr	..	..	1	..	..
26	Nilgiri wild goat or Nilgiri ibex	..	..	..	..	..
27	Serow or Himalayan goat antelope	..	..	5	..	..
28	Goral	..	2	12	..	..
29	Nilgai or blue bull	..	..	..	..	..
30	Four-horned antelope	..	..	..	..	..
31	Black buck	..	13	..	..	..
32	Indian gazelle or chinkara	..	..	..	..	..
33	Barking deer or kakar	..	62	152	..	..
34	Kashmir deer or hangul	..	..	..	..	..
35	Swamp deer or gond or barasingha	..	14	..	..	..
36	Brown-antlered deer or thamin	..	..	..	..	..
37	Sambar	..	..	20	3	..
38	Cheetal or spotted deer or axis deer	..	43	57	4	..
39	Hog deer or para	..	107	21	..	..
40	Musk deer	..	..	..	..	..
41	Mouse deer	..	..	..	..	..
42	Pangolin	..	..	..	..	..
43	Crocodile (muggar)	..	2	..	..	..
44	Gharial	..	..	..	..	..
45	Python	..	103	..	..	..
46	*Other (species given)*					
	Jackals	..	..	..	..	2
	Wild pig	..	13	228	4	..
	Hare	..	..	5	..	..
	Porcupine	..	94	1	7	..
	Jungle fowl	..	185	681	..	..

INDIAN PROVINCES AND STATES DURING 1948–49
FOREST RESEARCH INSTITUTE, DEHRA DUN

Madhya Pradesh	Coorg	Madras	Orissa	Punjab	Uttar Pradesh	Jammu & Kashmir	Mysore
8	9	10	11	12	13	14	15
49	6	19	..	..	..	..	9
14	..	2	..	..	..	..	..
44	23	21	..	40	..	..	..
..	..	22	..	..	..	..	..
..	..	..	..	..	..	..	..
..	..	1	..	..	..	..	..
1	..	..	..	1	..	..	..
..	..	..	..	2	..	..	..
14	7	19	..	..	..	..	2
..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..
..	..	1	..	..	..	..	..
..	..	1	..	..	..	..	..
..	..	..	..	..	..	..	..
29	..	7	..	..	..	..	..
..	1	1	..	..	..	..	3
..	1	..	..	..	..	..	..
9	..	11	..	..	..	..	1
..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..
1	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..
..	..	4	..	..	..	..	..
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..	..	2	..	..	..	..	..
3	..	..	..	..	..	..	..
..	..	..	..	11	..	..	..
45	..	..	..	4	..	..	..
..	..	..	..	..	..	..	..
..	..	1	..	..	..	..	..
17	..	..	..	..	..	..	..
28	..	29	..	33	..	..	2
..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..
88	..	21	..	1	..	..	2
92	3	19	..	10	..	..	5
18	..	..	..	12	..	..	..
..	..	..	..	..	..	..	..
..	..	14	..	..	..	..	..
..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..
..	1	1	..	..	..	..	..
112	..	1	..	6	..	..	..
398	..	10	..	110	..	..	..
..	10	..	..	..	..	..	..
..	..	2	..	35	..	..	..
7	..	4	..	..	..	..	1

(contd.)

All-India Serial No.	Species	Ajmer-Merwara	Assam	Bengal	Bihar	Bombay
1	2	3	4	5	6	7
46	*Others* (*species given*)—contd.					
	Pea fowl	..	160	44	..	..
	Imperial pigeon	..	..	39	..	..
	Grean pigeon	..	110	40	..	..
	Pigeons	..	280	59	..	..
	Kalij pheasant	..	..	82	..	..
	Wood snipe	..	..	47	..	..
	Partridge	..	194	6	..	..
	Wild duck	..	..	24	..	..
	Wood cock	..	..	1	..	..
	Goonch	..	..	4	..	..
	Fox	..	35	..	..	..
	Fish—Cutley	..	..	171	..	..
	Mahseer	..	..	157	..	..
	Others	..	..	171	..	..

Madhya Pradesh	Coorg	Madras	Orissa	Punjab	Uttar Pradesh	Jammu & Kashmir	Mysore
8	9	10	11	12	13	14	15
..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..
..	..	8	..	..	..	..	..
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(concld.)

STATEMENT OF WILD ANIMALS SHOT IN SOME OF THE

BY PUBLICITY AND LIAISON OFFICER,

All-India Serial No.	Species	Ajmer-Merwara	Assam	Bengal	Bihar	Bombay
1	2	3	4	5	6	7
1a	Tiger	..	..	9	..	..
1b	Tigress	..	..	6	..	..
2	Leopard or panther	..	..	33	..	..
3	Wild cats (species to be given, if known)	..	..	19	..	..
4	Lynx	..	..	..	..	..
5	Hunting leopard or cheetah	..	..	..	..	..
6	Hyena	..	..	..	..	..
7	Wolf	..	..	..	..	..
8	Wild dog	..	..	1	..	..
9	Martens	..	..	..	..	..
10	Ratel	..	..	..	..	..
11	Brown bear	..	..	..	..	..
12	Himalayan black bear	..	..	13	..	..
13	Malayan bear	..	..	..	..	..
14	Sloth bear	..	..	3	..	..
15	Wild elephant	..	..	1	..	..
16	Rhinoceros (species to be given)	..	..	..	..	..
17	Gaur or bison	..	..	..	..	..
18	Goyal or mithan	..	..	..	..	..
19	Banting or tsine	..	..	..	..	..
20	Wild buffalo	..	..	..	..	..
21	Urial or sharpu	..	..	..	..	..
22	Bharal or blue sheep	..	..	..	..	..
23	Ibex	..	..	..	..	..
24	Markhor	..	..	..	..	..
25	Tahr	..	..	..	..	..
26	Nilgiri wild goat or Nilgiri ibex	..	..	..	..	..
27	Serow or Himalayan goat antelope	..	..	10	..	..
28	Goral	..	..	17	..	..
29	Nilgai or blue bull	..	..	..	..	..
30	Four-horned antelope	..	..	..	..	..
31	Black buck	..	..	..	..	..
32	Indian gazelle or chinkara	..	..	..	..	..
33	Barking deer or kakar	..	..	206	..	..
34	Kashmir deer or hangul	..	..	..	..	..
35	Swamp deer or gond or barasingha	..	..	..	..	..
36	Brown-antlered deer or thamin	..	..	..	..	..
37	Sambar	..	..	31	..	..
38	Cheetal or spotted deer or axis deer	..	..	..	..	..
39	Hog deer or para	..	..	41	..	..
40	Musk deer	..	..	..	..	..
41	Mouse deer	..	..	..	..	..
42	Pangolin	..	..	..	..	..
43	Crocodile (muggar)	..	..	..	..	..
44	Gharial	..	..	..	..	..
45	Pythen	..	..	1	..	..
46	*Others (species given)*					
	Wild pig	..	..	353	..	..
	Jackals	..	..	..	..	..
	Hare	..	..	3	..	..
	Other deer	..	..	..	..	..
	Porcupine	..	..	1	..	..

INDIAN PROVINCES AND STATES DURING 1949-50

FOREST RESEARCH INSTITUTE, DEHRA DUN

Madhya Pradesh	Coorg	Madras	Orissa	Punjab	Uttar Pradesh	Jammu & Kashmir	Mysore
8	9	10	11	12	13	14	15
64	7	12	..	5	..	..	..
16	26	1	..	1	..	..	..
48	..	24	..	30	..	..	
..	..	34	..	..	..	..	..
..	..	..	..	..	..	..	..
1	..	..	..	..	..	..	..
..	..	..	..	2	..	..	..
..	..	..	..	5	..	..	..
5	2	24	..	..	..	..	..
..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..
..	..	1	..	5	..	..	..
..	..	..	..	5	..	..	..
..	..	..	..	..	..	..	..
21	..	2	..	..	..	..	..
..	..	5	..	..	..	..	..
..	..	..	..	..	..	..	..
11	..	17	..	..	..	..	..
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..	..	..	..	..	..	..	..
2	..	..	..	..	..	..	..
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..	..	..	..	..	..	..	..
..	..	1	..	..	..	..	..
..	..	..	..	28	..	..	..
67	..	..	..	6	..	..	..
7	..	1	..	..	..	..	..
..	..	..	..	..	..	..	..
21	..	..	..	..	..	..	..
47	..	25	..	40	..	..	..
..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..
139	..	12	..	3	..	..	..
97	1	15	..	5	..	..	..
..	..	..	..	6	..	..	..
..	..	..	..	..	..	..	..
..	..	14	..	..	..	..	..
..	..	..	..	..	..	..	..
1	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..
345	1	4	..	172	..	..	..
162	..	..	..	30	..	..	..
..	..	..	..	..	..	..	..
13	..	..	..	..	..	..	..
..	..	8	..	63	..	..	..

(contd.)

All-India Serial No.	Species	Ajmer-Merwara	Assam	Bengal	Bihar	Bombay
1	2	3	4	5	6	7
46	*Others* (*species given*)—contd.					
	Fox	..	..	..	..	..
	Jungle fowl	..	..	681	..	..
	Monkey	..	..	..	..	..
	Pea fowl	..	..	60	..	..
	Grey and Red mangoose ..	..	..	..	..	..
	Imperial pigoen	..	..	56	..	..
	Green pigeon	..	..	36	..	..
	Pigeons	..	..	43	..	..
	Kalij pheasant	..	..	81	..	..
	Wood snipe	..	..	37	..	..
	Partridge	..	..	4	..	..
	Wild duck	..	..	2	..	..
	Wood cock	..	..	2	..	..
	Goonch	..	..	..	..	..
	Fish-Cutley	..	..	156	..	..
	Mahseer	..	..	162	..	..
	Others	..	..	124	..	..
	Jungle sheep	..	..	..	..	..
	Black panther	..	..	..	..	..

Madhya Pradesh	Coorg	Madras	Orissa	Punjab	Uttar Pradesh	Jammu & Kashmir	Mysore
8	9	10	11	12	13	14	15
..	..	..	..	5	..	..	..
..	..	..	..	..	..	..	..
..	..	..	..	560	..	..	..
11	..	..	..	..	..	..	..
..	..	47	..	..	..	..	..
..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..
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..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..
..	..	7	..	..	..	..	..
..	..	9	..	..	..	..	..
..	..	3	..	..	..	..	..

STATEMENT OF WILD ANIMALS SHOT IN SOME OF THE

BY PUBLICITY AND LIAISON OFFICER,

All-India Serial No.	Species	Ajmer-Merwara	Assam	Bengal	Bihar	Bombay
1	2	3	4	5	6	7
1a	Tiger	..	55	13	..	..
1b	Tigress	..	1	6	..	..
2	Leopard	..	8	19	..	..
3	Wild cats (species to be given, if known)	..	7	12	..	..
4	Lynx	..	..	..	..	..
5	Hunting leopard or cheetah ..	..	16	..	..	..
6	Hyena	..	5	..	..	..
7	Wolf	..	4	..	..	..
8	Wild dog	..	38	4	..	..
9	Martens	..	..	6	..	..
10	Ratel	..	..	..	..	..
11	Brown bear	..	40	..	..	..
12	Himalayan black bear	..	1	6	..	..
13	Malayan bear	..	..	..	..	..
14	Sloth bear	..	175	..	..	..
15	Wild elephant	..	26	..	..	..
16	Rhinoceros (species to be given) ..	..	..	..	..	..
17	Gaur or bison..	..	..	..	..	..
18	Goyal or mithan	..	..	..	..	..
19	Banting or tsine	..	..	..	..	..
20	Wild buffalo	..	16	..	..	..
21	Urial or sharpu	..	..	..	..	..
22	Bharal or blue sheep	..	..	..	..	..
23	Ibex	..	..	..	..	..
24	Markhor	..	..	..	..	..
25	Tahr	..	..	..	..	..
26	Nilgiri wild goat or Nilgiri ibex ..	..	18	..	..	..
27	Serow or Himalayan goat antelope ..	..	..	6	..	..
28	Goral	..	20	7	..	..
29	Nilgai or blue bull	..	..	..	..	..
30	Four-horned antelope	..	..	..	..	..
31	Black buck	..	..	..	..	..
32	Indian Gazelle or chinkara ..	..	..	..	..	..
33	Barking deer or kakar	..	251	211	..	..
34	Kashmir deer or hangul	..	..	..	..	..
35	Swamp deer or gond or barasingha ..	..	..	..	..	..
36	Brown antlered deer or thamin ..	..	168	..	..	..
37	Sambar	..	..	6	..	..
38	Cheetal or spotted deer or axis deer ..	..	..	5	..	..
39	Hog deer or para	..	20	38	..	..
40	Musk deer	..	..	..	..	..
41	Mouse deer	..	..	..	..	..
42	Pangolin	..	..	..	..	..
43	Crocodile (muggar)	..	..	..	..	..
44	Charial	..	..	..	..	..
45	Python	..	4	..	..	..
46	*Others (species given)*					
	Wild pig	..	5	321	..	..
	Bore	..	718	..	..	..
	Hare	..	..	18	..	..
	Fox	..	80	..	..	..
	Porcupine	..	..	1	..	..

INDIAN PROVINCES AND STATES DURING 1950–51

FOREST RESEARCH INSTITUTE, DEHRA DUN

Madhya Pradesh	Coorg	Madras	Orissa	Punjab	Uttar Pradesh	Jammu & Kashmir	Mysore
8	9	10	11	12	13	14	15
63	..	..	..	..	..	..	..
15	..	..	..	..	..	..	..
64	..	..	..	28	..	..	..
25	..	..	..	..	..	..	..
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32	..	..	..	..	..	..	..
..	..	..	..	2	..	..	..
3	..	..	..	..	..	..	..
11	..	..	..	..	..	..	..
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..	..	..	..	..	..	..	..
..	..	..	..	1	..	..	..
1	..	..	..	12	..	..	..
..	..	..	..	..	..	..	..
46	..	..	..	..	..	..	..
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..	..	..	..	..	..	..	..
6	..	..	..	..	..	..	..
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3	..	..	..	..	..	..	..
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..	..	..	..	4	..	..	..
174	..	..	..	1	..	..	..
6	..	..	..	..	..	..	..
1	..	..	..	..	..	..	..
6	..	..	..	..	..	..	..
65	..	..	..	1	..	..	..
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154	..	..	..	11	..	..	..
138	..	..	..	14	..	..	..
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443	..	..	..	..	..	..	..
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1	..	..	..	101	..	..	..

(*contd.*)

All-India Serial No.	Species	Ajmer-Merwara	Assam	Bengal	Bihar	Bombay
1	2	3	4	5	6	7
46	*Others (species given)*—contd.					
	Monkeys	..	728	..	..	..
	Jungle fowl	..	..	1,146	..	..
	Jackals	..	..	..	..	..
	Pea fowl	..	..	45	..	..
	Other deer	..	..	..	..	..
	Imperial pigeon	..	..	146	..	..
	Peacock	..	..	..	..	..
	Green pigeon	..	..	74	..	..
	Pigeons	..	..	46	..	..
	Kalij pheasant	..	..	98	..	..
	Wood snipe	..	..	32	..	..
	Partridge	..	..	10	..	..
	Wild duck	..	..	48	..	..
	Wood cock	..	..	1	..	..
	Goonch	..	..	..	..	..
	Fish—Cutley	..	..	177	..	..
	Mahseer	..	..	173	..	..
	Others	..	..	69	..	..

Madhya Pradesh	Coorg	Madras	Orissa	Punjab	Uttar Pradesh	Jammu & Kashmir	Mysore
8	9	10	11	12	13	14	15
..	..	..	..	5	..	..	..
1	..	..	..	..	..	..	..
78	..	..	..	27	..	..	..
..	..	..	..	..	..	..	..
37	..	..	..	..	..	..	..
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5	..	..	..	..	..	..	..
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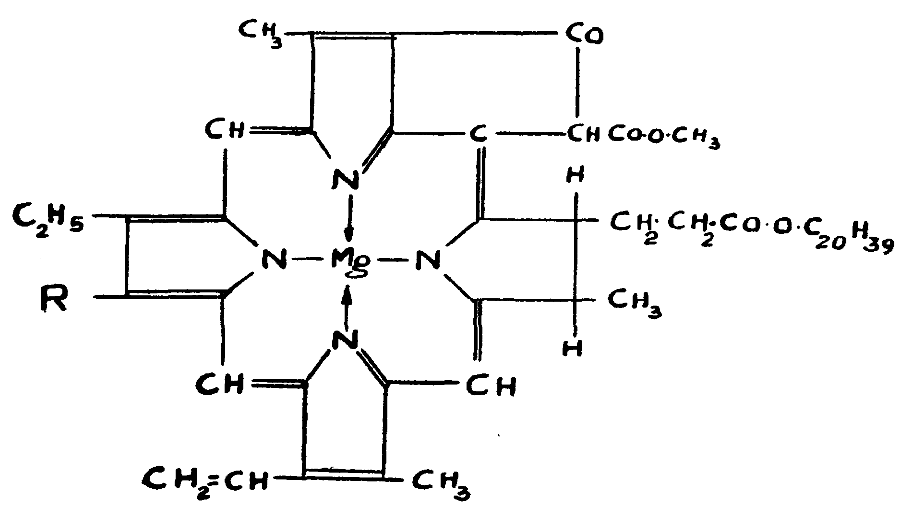
A NOTE ON THE PREPARATION AND USES OF COPPER CHLOROPHYLL

BY S. V. PUNTAMBEKAR AND P. RAMACHANDRA RAO

It has been shown by Willstätter[1] that the magnesium present in the chlorophyll molecule (I) is capable of being replaced by other metals like copper and zinc. Of all the metallic derivatives of chlorophyll, the copper compound, which is popularly known as copper chlorophyll (II) and is in fact a derivative of phæophytin (III), is the most outstanding.

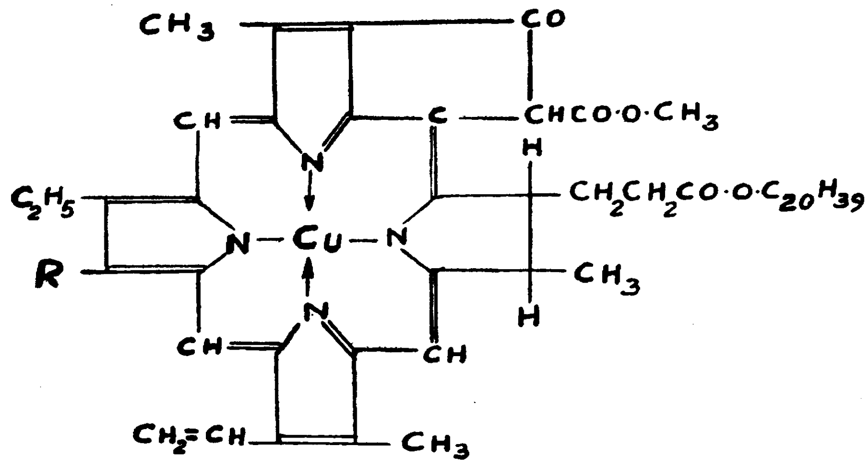
Copper chlorophyll is more stable to the action of acids and light than the parent compound. It is quite soluble in fixed oils and fats and solvents like benzene, chloroform, acetone and alcohol. It has come into great prominence on account of the brilliant attractive green shades it is capable of imparting to soaps. For this purpose it has several advantages which are unique. It readily blends with soap to give uniform colour. It does not act as a substantive dye on fabrics so that the soap can be freely used for washing purposes. Further it is reported to possess tissue-stimulating properties also[2] so that it can be used with advantage to colour toilet soaps. In addition to its uses in soap industry, copper chlorophyll is also useful for the colouring of hair oils and ointments for external application. It is worthwhile to note that chlorophyll ointments and solutions have great healing power for wounds and cuts and remove bad odours from them[3, 4].

In spite of its extensive uses, existing and potential, in the soap, hair oil and other cosmetic industries, there has been so far no manufacture of either chlorophyll or its derivatives in India. Nor are any details known of the different methods of manufacturing copper chlorophyll adopted by foreign firms who employ their own methods based "on research and experience"[5]. It is reported that an American company (Valley Vitamins, Inc., McAllen, Tex.) prepares the copper chlorophyll starting with pure chlorophyll and treating it first with acid benzene-isopropyl alcoholic solutions and then with copper sulphate in methyl alcohol[6].



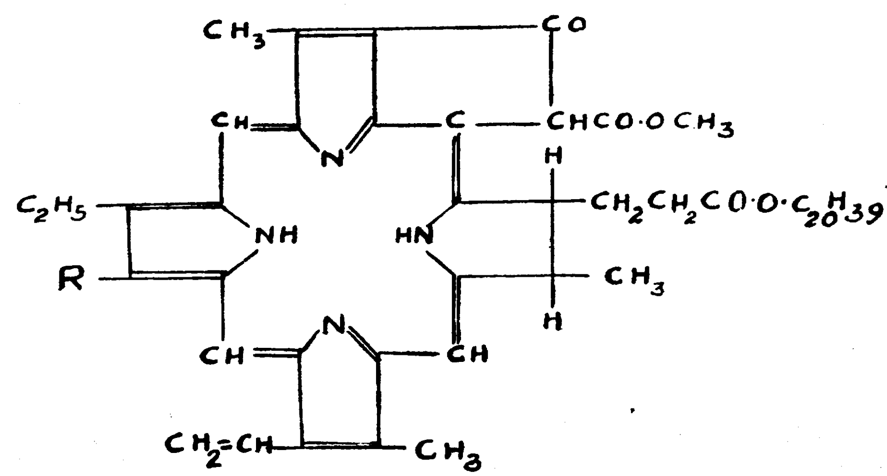
Chlorophyll a ($R = CH_3$) and chlorophyll b ($R = CHO$)

STRUCTURAL FORMULA I.



Copper chlorophyll ($R = CH_3$ or CHO.) .

STRUCTURAL FORMULA II.



Phœophytin a ($R = CH_3$) and Phœophytin (b)
($R = CHO$)

STRUCTURAL FORMULA III

A method has now been developed in this laboratory for the preparation of copper chlorophyll without resorting to the isolation of the pure chlorophyll and the use of costly solvents. Unlike in the case of chlorophyll preparations intended for use in the edible oils[7], any leafy material rich in chlorophyll can be used with advantage for the preparation of copper chlorophyll.

Preparation of Copper Chlorophyll—Particularly the following methods have now been developed and found useful :—(1) Dry leaf powder of *Urtica parviflora* Roxb. (25 g.) is mixed with copper sulphate (2 g.) and boiled for ten hours under reflux with alcohol (150 c.c.) acidified with concentrated hydrochloric acid (2 c.c.). The mixture is then filtered under suction and from the filtrate, alcohol is removed by distillation. The resulting viscous liquid is filtered through a dry filter, washed with water and then with a few c.c. of absolute alcohol to remove traces of water (a large amount of the alcohol should not be used as the copper compound is soluble in it). The semi-solid remaining on the filter paper is copper chlorophyll along with the other alcohol extractives. The yield is 3 g. from 100 g. of leaf powder. However, the tinctorial value[8] of the product is found to be only 65 per cent.

(2) A product of higher purity and 120–140 per cent tinctorial value has been prepared by adopting the following process for which a provisional patent No. 47655 has already been filed with the Controller of Patents and Designs, Calcutta, and wherein are recorded the full details.

The air-dry leaf powder is moistened with copper sulphate solution and extracted with alcohol containing oxalic acid, for six hours in a copper soxhlet. The alcoholic extract, is concentrated and further refluxed for about four hours. During this treatment, the pigment is converted into phæophytin which separates out from the solution. The dull olive green product consisting mainly of phæophytin is filtered, mixed with copper sulphate and refluxed with alcohol. In about 6–8 hours, the formation of copper chlorophyll is complete. The alcoholic solution is then evaporated to obtain the copper chlorophyll. After a thorough wash with water in order to remove inorganic copper, if any, and subsequently with a few c.c. of absolute alcohol for preliminary dehydration, the product is allowed to dry at room temperature. The yield is two ounces per kilogram of leaf powder. The product can be further purified if necessary by extracting with chloroform under soxhlet, when a green pigment completely soluble in organic solvents is obtained in an yield of 92–95 per cent of the original product. The product is mixed up thoroughly with calculated amounts of refined castor oil to get a uniform viscous product having 100 per cent tinctorial value.

The product is soluble in chloroform, fixed oils and fats. It is insoluble in water and fairly soluble in alcohol. Although slightly contaminated with xanthophyll, carotenes and other alcohol extractives, copper chlorophyll thus prepared can be employed for colouration of soaps, hair oils and ointments, as the impurities do not interfere in any way.

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2. Westcott, F. H. American Perfumer and Essential Oil Review, 1950, 56, 285.
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VOLUME 79 NUMBER 3

INDIAN FORESTER

MARCH, 1953

SOIL EROSION

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SUMMARY

1. In the wake of the post-war reconstruction schemes, attention has come to be focussed on soil erosion as a major problem affecting land economy. The matter is to be viewed from different angles on cultivated and waste lands. On the former, soil conservation measures yield direct, quick and tangible results. The farmer is with and not against us. On waste-lands unfit for cultivation, however, the problem takes on a different complexion. These tracts are regarded as no-man's lands. They are subjected to the worst conceivable mal-treatment which spells wholesale destruction of vegetative cover. The imposition of the least little restriction on the improvident practices adopted by the peasants is objected to, opposed and made a grievance of. Attempts made in the Kulu valley, Kumaun, Chota Nagpur, Yamuna ravines, Nilgiris, to preserve a soil cover have made little, if any, headway. The problem of soil conservation in such areas is more a social than a technical problem. What is required is not research in determining the technique of soil conservation measures, but devising ways and means to enforce legislative measures to afford such areas protection against domestic animals.

2. Insistence on detailed surveys of the magnitude of the problem will only delay matters. By far the best method of tackling this problem is for the Centre to organize closely knitted demonstration centres throughout the land, – centres which States may replicate and emulate. As an earnest of their co-operation in the matter, the States should be asked to contribute 50 per cent of the total cost involved in the establishment of these centres.

3. The administrative organization proposed to be set up at the Centre for the purpose consists of a Director of Soil Conservation attached to the Board of Forestry, somewhat on the model of the Vice-Chairman of the Indian Council of Agricultural Research.

Soil erosion of late has aroused considerable interest in the wake of the initiation of the various development schemes seeking to ameliorate the rural conditions of the country, and more particularly in relation to the river valley projects. One hears of soil conservation at all agricultural, forest and irrigation conferences. A vast mass of literature has grown around the subject. There is hardly any aspect of the problem which has not been discussed threadbare. There are resolutions and recommendations galore, and yet conservation of soil has remained only a subject of conversation.

2. Broadly speaking, the problem of soil erosion presents itself in two forms :—

I. On cultivated lands, where the failure

(i) to vest the right of ownership of the land in its cultivator,

(ii) to consolidate the resources of tenants,

(iii) to devise proper landuse, and

(iv) to adopt correct agricultural practices, results in a general degradation of lands under cultivation. The least little weakening in vested interests and resources reflects on the upkeep of fields and leads to the loss of organic layer of top-soil by wind and water-borne erosion. This is essentially an agricultural problem.

II. On lands not under cultivation, the destruction of soil cover by

(i) over-felling,

(ii) excessive grazing,

(iii) shifting cultivation, and

(iv) fires,

induces rapid run-off and accounts for the loss of both moisture and top-soil. Corrective measures to be devised for such areas constitute a forest problem.

3. Of these two aspects of soil conservation, the problem of lands under agricultural crops is comparatively easy. The amendment of land laws inculating the sense of ownership in the tiller of the soil would turn sands into gold. Some of the finest agricultural fields in the world are to be seen in India, in regions where the tiller is also the owner of the land. Assistance to the cultivator need only take the form of the consolidation of his holdings and affording his fields protection against sheet erosion. The pooling of the resources of a community and corporate effort are generally required where land slopes demand special corrective measures for the conservation of both moisture and top-soil cover. The construction of *bundhis*, contour ploughing, strip cropping, and step cultivation constitute the chief among the various measures which have been adopted with great success in various parts of the country, e.g., Deccan; Bundelkhand; Himalayan tracts, etc. The problem is easy to handle on agricultural lands, because the results are quick, direct, and tangible. The amelioration of the soil reflects in increased crop yields and the average cultivator is with and not against us.

4. The problem of soil conservation takes on a completely different complexion, however, on non-agricultural lands – lands belonging not to the individual but to the State, or corporate bodies. What belongs to everybody, belongs to nobody. These no-man's lands are subjected to the worst conceivable maltreatment. In the quest of fuel, they are systematically stripped of tree-growth which constitutes a natural defence against the forces of Nature. They are overgrazed and burnt ostensibly to improve grazing. The least little check on the improvident habits of the populace leads to awful howls, often taking the form of organized agitation, the reverberations of which are heard in the Legislative Chambers. The average peasant is naturally not interested in any long-range programmes or policies. What matters to him is what immediately concerns him. How his improvident practices, reckless hacking down of trees and destruction of soil cover by his cattle, affect the physical conditions of the land are matters of no consequence to the villager. He resists any attempts which seek to limit the grazing for his sheep and goats. The imposition of any restrictions on the lopping and felling of trees for fodder and fuel is violently objected to. Thus, the afforestation scheme of the Yamuna ravines in the Uttar Pradesh had to be considerably whittled down to accommodate the goatiers. The Kulu valley where sheep replace goats has the same dismal tale to tell. The hill slopes in Orissa and elsewhere are fast being depleted of the defences they have in their vegetable cover, because little control can be exercised on the shifting cultivation, and on the number of cattle which are let loose to graze in these critical areas. Large tracts of beautiful oak forests in Kumaun have been lopped to death. In the Nilgiris, the vandalism has taken the form of putting magnificient Eucalyptus plantations raised with great care, under potatoes. In the Chota Nagpur plateau, we have the spectacle

of reckless destruction of soil cover by the local populace which is blissfully ignorant and supremely unconcerned about the consequent floods in the Damodar valley.

5. The fact of the matter is that the protection of soil cover in areas unfit for cultivation and in marginal lands is more a social than a technical problem. In most localities conditions are so conducive to the growth of vegetation, that often the exclusion of domestic cattle is all that is required. Such areas are clamouring, not for elaborate soil conservation measures, but for mere protection against incessant grazing. For adopting these elementary protective measures, what is needed is not academic research, but laws to control grazing both in space and time. Methods of reclothing hill slopes, and of afforesting various types of soils are too well-known to justify postponement of action on the score of lack of knowledge of technique.

6. Stress is usually laid at various conferences on the need for carrying out a country-wide survey of the problems relating to soil erosion. Most elaborate information is usually called for. This inordinate emphasis on surveys serves no other purpose except diverting attention into fruitless channels. No one denies the value of the survey of the extent of the problem, but what escapes recognition is the fact that the expense of time and money involved in the collection of a vast mass of facts and figures is generally entirely disproportionate to the advantage gained. Thus, for the Himalayan tract in the Uttar Pradesh, to take an example at random, a detailed survey, carried out by me, revealed :—

	Milacres	Percentage of total area
TOTAL AREA	9,574	100
I. Cultivated	877	9·2
Total	877	9·2
II. Culturable		
(a) Current fallow.. ..	85	0·9
(b) Old fallow	27	0·3
(c) Groves	5	0·05
(d) Waste	340	3·6
	98 (hills)	1·0
Total ..	555	5·8
III. Barren		
(a) Covered with water ..	52	0·6
(b) Sites, roads, etc. ..	31	0·3
(c) Otherwise barren ..	95	1·0
	245 (hills)	2·5
Total ..	423	4·4
IV. Forests		
(a) Under Forest Deptt. ..	3,850	40·2
(b) Civil	3,673	38·4
(c) Private	196	2·0
Total ..	7,719	80·6

Population 123 per sq. mile. Milacre = 1,000 acres.

7. From the point of view of the soil conservation measures to be adopted in the tract, these figures are interesting but not instructive. Almost the entire civil area classed as 'forest' amounting to 3·673 million acres, has been degraded by continuous burning and grazing to a state which beggars description. With our limited resources, we cannot reclaim more than a fraction of the area. Information of a similar, though not of so detailed a nature, can be supplied for the Chota Nagpur plateau, Hoshiarpur Siwaliks, the valleys of the Damodar, Yamuna and Kosi, and for a large number of other tracts in the country. But what good do these figures serve ? One naturally exclaims : so what ?

8. It occurs to me that the problem of soil conservation, if it is to be tackled at all, should be tackled piecemeal, the limiting factors being men and money. The only rational approach to this vast problem is to take in hand a chain of pilot projects in various types of localities all over the country for demonstrating what can be achieved by adopting soil conservation measures. The Planning Commission has made a provision of Rs. 2 crores for the purpose. As an earnest of their earnestness, the States should be called upon to contribute 50 per cent of the total costs involved. This will make the funds available for the purpose go twice as far. These pilot demonstration centres will act as nuclei for intensive studies and serve as models for the States to replicate and emulate.

9. The organization to be set up to knit these demonstration centres dotted all over the country into an integrated unit should follow the pattern provided by the Indian Council of Agricultural Research. The Board of Forestry which is constituted at the ministerial level and has heads of Forest Departments of various States as observers, provides a readymade organization of which advantage should be taken for the purpose. The Director of Soil Conservation, who should be vested with the status of the Vice-President of the I.C.A.R., should be a whole time officer attached to the Board which will perform the following functions :—

(1) To organize demonstration centres for soil Conservation.

(2) To advise States on suitable legislative measures to arrest further degradation of lands by reckless exploitation.

(3) To co-ordinate inter-state soil conservation projects.

(4) To arrange for publicity, and training of workers.

(5) To organize reconnaissance surveys.

10. The Director of Soil Conservation will have under him a batch of trained technicians (foresters, soil scientists, surveyors, etc.) whose services will be made available for the States. He will also be in direct charge of the Rajputana Desert Research Station at Jodhpur, as also of the Soil Conservation Branch at the Forest Research Institute, Dehra Dun.

11. The agricultural side of the conservation of soil should be the responsibility of the Indian Council of Agricultural Research, of which the Director of Soil Conservation should be a member. There is nothing to be gained by setting up a separate All-India organization for Soil Conservation ; advantage should be taken of the existing ones.

TREK TO GANGOTRI (Source of the Ganga)

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1. *General*—From very ancient times thousands of devout Hindus (both men and women) have yearly been doing the Uttarakhand Yatra (or the pilgrimage to the holy places in the snowy Himalayas). This pilgrimage is done via sacred places in the plains such as Hardwar and Rishikesh on the Ganga, and includes a visit to Yamunotri (the source of the river Yamuna), Gangotri (the source of the river Ganga), both in the district of Tehri Garhwal, Shri Kedarnath (on the river Mandakini) and Shri Badrinath (on the river Alaknanda), the last two in the district of Garhwal. The last 4 places are in the Himalayas at a height of over, 10,000 feet above sea-level.

2. For the convenience of pilgrims an institution called Shri 108 Baba Kali Kamli Wala Panchayati Kshetra, Rishikesh, maintains a large number of *dharamshalas* on the route which provide facilities for the stay of pilgrims. At important *dharamshalas* blankets, cooking utensils and medicines are also provided. Grocery shops containing provisions like *ghee*, flour, rice, *dal*, potatoes, salt, etc., and tea shops are also found at these places. No fresh vegetables and fruits are locally available. Tinned stores can be purchased in Rishikesh, but it is safer to bring one's own or buy them at Dehra Dun.

3. The present article deals with the trek to Gangotri only, which can be done easily in about three weeks.

4. *Source of the Ganga*—Gangotri is commonly supposed to be the source of the holy river Ganga but it is not really so. The actual source is not known with certainty. The end of a glacier about 15 miles beyond Gangotri, is considered to be the source and is called Gaumukh. Some travellers who have gone to Mansarovar (in Tibet) past Gaumukh, state that the river Bhagirathi (as the Ganga is known in the higher regions) can be traced even beyond Gaumukh.

5. *The route*—Gangotri is about 151 miles from Rishikesh Railway Station (Northern Railway). Rishikesh is the terminus of a branch line of the Northern Rly. from Hardwar, a station on Lhaksar–Dehra Dun branch, and is easily accessible.

6. There is a regular motor service from Rishikesh in the plains to Tehri in the hills a distance of 51 miles. From Tehri there is a fair weather motor service up to Dharasu – a distance of 27 miles. This service generally runs from November to June. Gangotri is about 74 miles from Dharasu, along a fairly well aligned bridle path, though this path is quite narrow and rocky in places. A sketch map showing the route is enclosed.

7. *Travellers bungalows*—All along the route there are places, locally called *chattis* or *dharamshalas*, where pilgrims can stay for the night (see para 2). The following are the main halting stations from Dharasu :—

Serial No.	Name	Distance in miles from previous halt	Height in feet above sea-level
1	Dharasu	0	3,400
2	Nakuri	11½	3,400
3	Uttarkashi	7	4,000
4	Maneri	10	4,500

(contd.)

Serial No.	Name	Distance in miles from previous halt	Height in feet above sea-level
5	Bhatwari	8	5,000
6	Gangnani	9	6,000
7	Sukhi	9	8,700
8	Harsil	6	8,000
9	Jangla	6	8,600
10	Bhaironghati	3	8,700
11	Gangotri	6	10,000

8. Forest Rest-houses (F.R.Hs.) exist at Nos. 1 to 6 and 8. There are good *dharamshalas* also at all the above places except Nos. 2 and 9. F.R.Hs. are properly furnished with furniture including cots, cooking and eating utensils, a tea set, a lamp, a lantern and kerosine oil. Commodes are provided but no sweepers are locally available. The F.R.Hs. generally have 2 bed rooms and 2 bath rooms with outhouses for servants. Only Maneri F.R.H. has no outhouses at present but there are 2 *dharamshalas* nearby. A permit to occupy the F.R.Hs. can be had from the Divisional Forest Officer, Uttarkashi Forest Division, P.O. Uttarkashi, District Tehri Garhwal. The charges are Rs. 2 per suit of rooms per night for those not on duty.

9. *Season of pilgrimage*—Gangotri remains covered with snow from November to April. So, the route is open only from May to October though during the monsoon months (July to September) landslips are likely to occur which might make the path impassable. The main pilgrim season is May and June and is very pleasant. An ordinary warm coat and 2 blankets are all that are required at night even at Gangotri. As rains may occur a raincoat and an umbrella are essential.

10. *Means of transport*—Means of transport have to be fixed at Dharasu. Porters and mules are available to carry luggage while ponies and *dandies* can be had by those who cannot or do not wish to walk. Very often a porter carries light pilgrims (mostly old women) in a '*kandy*' – a *ringal* chair which the porter straps on to his back. Porters charge Rs. 2/8/- to 3 per day while the charges for mules and ponies are Rs. 4 to 5 per day. A mule carries about 2 maunds of luggage, a load of a maund slung on either side, while a porter carries a load up to 30 seers (3/4th of a maund or 60 lbs.). A porter charges also by weight, say Rs. 4 per seer or Rs. 120 for a weight of 30 seers per trip, of about a month. Porters are more useful than mules since at several places the road is difficult for loaded mules; again, porters are useful in collecting firewood and fetching water.

11. *Weight of luggage packages*—Mules can easily go up to Bhatwari. From Bhatwari onwards some parts of the path are so rocky and narrow, with overhanging cliffs and rocky steps, that a loaded mule has to be unloaded and led out by hand. At these places porters are required to carry the luggage. So, from Bhatwari onwards it is essential that luggage should be carried in bundles which do not exceed 25 to 30 seers in weight, and can easily be carried by porters. The portions which are particularly bad occur for about 2 miles between Gangnani and Sukhi and about 1½ miles just before Bhaironghati.

12. In these parts herds of goats and sheep are generally used to carry provisions in bags, for the inhabitants of the higher regions. They carry up to 10 seers on either side.

13. *The journey*—The journey may be divided into two parts :—

(i) The bus journey from Rishikesh to Dharasu – a distance of 77 miles.

(ii) The journey on foot from Dharasu to Gangotri – a distance of 74 miles.

14. The road from Rishikesh to Dharasu is a hilly one on which there is only one way traffic. One catches a bus from Rishikesh at 7 a.m. for Tehri and reaches there at 1 p.m. Though the height of Rishikesh is only 1,200 feet and that of Tehri 2,100 feet the motor road twice ascends to a height of 5,000 feet, viz., at Agrakhal and Chamakhal and then descends. From Tehri one gets a bus for Dharasu at 1:30 p.m. and reaches there by 5:30 p.m.

15. From Dharasu the trek starts. The bridle path follows the valley of the Bhagirathi, mostly the right bank. The hill-sides are clothed with forests while cultivation is done in the valleys and along gentle slopes in the hills.

16. Cultivation on the hill slopes causes erosion and in course of time destruction of the fields.

17. Uttarkashi is the first and only important town on this trek, about 18 miles from Dharasu. It is regarded as a very sacred place by the Hindus and contains a number of temples the most important being that of Vishwanathji.

18. The town is on the right bank of the Bhagirathi and has *ghats*. It contains a post office, a *thana* and a hospital; is the Headquarter of the Sub-Divisional Officer and contains a High School. The Divisional Forest Officer lives at Kot, 2 miles off from Uttarkashi. The valley is fairly wide at Uttarkashi.

19. From Maneri to Bhatwari there are hardly any forests on the right side of the stream; some forests occur on the left side.

20. There are some very ancient temples at Bhatwari.

21. All along the valley there are a number of *nalas* and rivulets. There are some picturesque waterfalls, and occasionally one gets a glimpse of the snows.

22. There is a good suspension bridge between Bhatwari and Gangnani. From this place to Gangnani the bridle path follows the left bank of the Bhagirathi.

23. At Gangnani there is a hot sulphur spring. Two small *pacca* tanks have been made to enable people to have a bath in them.

24. Beyond Gangnani, and 2 miles before Sukhi, one comes across the steepest climb of the trek. Beyond Sukhi, the route descends rather less steepy to Jhala. The route is very dreary and the path full of loose stones.

25. *An interesting geological formation*—The Bhagirathi river is mostly a hill stream above Nakuri. Its bed is strewn with rocks and boulders. But an interesting geological formation is noticed between Sukhi and Jangla over a distance of about 12 miles. The bed of the river suddenly broadens to more than 2 furlongs. In place of boulders and rocks in the bed of the river one finds white shingle and gravel. This formation is most striking as just before and after this, i.e., between Bhatwari and Sukhi (a distance of 18 miles) and again from Jangla to Gangotri (a distance of 9 miles) the valley is quite narrow and the bed of the river is full of rocks and boulders; also there are precipitous rocky hills on both sides and the river presents the appearance of a narrow gorge.

26. Harsil is a beautiful place. The valley is broad. It has good apple orchards. It is surrounded on all sides by snow capped hills. The F.R.H. at Harsil is a commodious building of deodar and resembles with its background a Swiss chalet.

The scenery one comes across on the route from Harsil to Bhaironghati is the most beautiful of the entire trek.

27. A girder bridge has been constructed near Bhaironghati over a gorge. Before this bridge was constructed pilgrims had to go over a dangerous rope bridge. Just before Bhaironghati there is an ascent of about 1½ miles and the path is narrow and rocky and impassable for loaded mules.

28. During the monsoon considerable damage is done by the debris brought down by the hill streams. A portion of the village of Dharali (2½ miles beyond Harsil) including its temple has been buried under debris brought down by recent floods.

29. *Gangotri*—At Gangotri is the famous temple of the Goddess Ganga.

30. The temple, the *dharamshalas* and the village of Gangotri are all on the right bank of the river. On the left bank mostly the ascetics and *sadhus* live in small huts. A small temporary bridge connects the two banks.

There is hardly any path beyond Gangotri towards Gaumukh and so the journey is very tedious.

31. *The forests*—The character of vegetation changes with the height above sea-level. From Dharasu (3,400 feet) to Maneri (4,500 feet) one finds scrub miscellaneous forests of the plains along the river with chir (*Pinus longifolia*) forests along the hill slopes.

Between Maneri and Bhatwari, on the left cooler southern aspect, some silver fir (*Abies pindrow*) forests are to be seen for the first time on the slopes of the hills. Between Gangnani (6,000 feet) and Harsil (8,000 feet) one comes across mostly cypress (*Cupressus torulosa*) trees. From Harsil (8,000 feet) to Gangotri (10,000 feet) the forests consist mostly of deodar (*Cedrus deodara*) with some *kail* (*Pinus excelsa*) and occasional spruce (*Picea morinda*) and silver fir.

32. Some birch (*Betula utilis*) forests occur beyond Gangotri. Oaks are conspicuous by their absence but for a small patch near Gangnani. Among other broad leaved species walnut (*Juglans regia*), alder (*Alnus nitida*), maple (*Acer* spp.), *tun* (*Cedrela toona* and *serrata*) are common with occasional *Rhododendron arboreum,* and horse chestnut (*Aesculus indica*). Natural regeneration of chir, deodar and *kail* is good everywhere.

33. *Method of extraction*—The most common and valuable conifers are chir, deodar, *kail,* silver fir and spruce. Trees are marked and then sold standing to contractors in public auction. The marked trees are felled by axe and saw combined and converted mostly into B.G. sleepers (12′ × 10″ × 5″). Sleepers are carried by porters to the edge of *nalas,* taken down the *nalas* by wet slides to the main stream for floating and then launched down the Bhagirathi, at the end of the monsoon (usually September–October).

34. *Obstructions in beds of streams*—In certain places there are a large number of obstructions - rocks, boulders, etc., in the bed of the main stream (Bhagirathi) where sleepers get entangled and are thus lost to the trade. These obstacles are fairly common between Bhatwari and Sukhi and again between Jangla and Gangotri. This loss sometimes amounts to as much as 20 to 25 per cent of the number of pieces launched and corresponds to a loss of about rupees seventy thousand annually. Sometimes the sleepers dash against rocks at the bends in streams and get broken.

To salvage the timber the contractor has to employ a gang of labourers which walks along the bed of the stream and releases the entangled sleepers, etc. This operation greatly adds to the cost of floating. So, if the obstacles in the bed of the Bhagirathi are removed, by blasting, so that there is a clear passage in the middle of the stream, about 12 feet wide,

the loss of timber during floating would be greatly reduced and the floating charges would become much less. In that case the auction price obtained for the timber at the sales would increase by 10 to 15 per cent equivalent to rupees thirty-five to fifty thousand.

35. *Miscellaneous hints*—There are swarms of flies during May and June all along the route up to Gangnani. So, a tin of flit and a mosquito net are essential. All drinking water should be boiled before use. As the valleys are quite warm during May and June it is advised to make a move from camp early in the morning say at 6 a.m., up to Gangnani, whence the altitude acts as a foil to the heat.

36. *Dak* and fresh supplies of vegetables, fruits, bread, eggs, etc., can be arranged from Mussoorie, which is about 40 miles from Dharasu by a bridle path. The average speed of a porter is 2 to 2½ miles per hour and so he can be expected to travel 12 to 15 miles per day.

37. In arranging a tour programme it is advisable to have a halt after every 2 or 3 marches to give rest to one's own self and also to porters and camp followers. A halt is advised at Uttarkashi, Bhatwari, Harsil and Gangotri.

38. A radio, a camera and a first aid box of medicines should form essential part of equipment. No fire arms are required as shooting is prohibited in these religious places.

A STUDY INTO THE THINNING INTENSITIES FOR PLANTATION SAL (*SHOREA ROBUSTA*)

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SUMMARY

In order to study the development of plantation sal under different grades of thinning, a set of 3 sample plots was laid out in a 5-year old crop in Kalimpong Division of West Bengal, in 1930. The plots were measured and thinned in 1936, 1941, 1946 and 1951. The investigation has been described, the data analysed and results discussed. It appears that for top quality sal plantations maximum basal area and total volume production is obtained under the 'C/D' grade of thinnings. The 'D' grade gives approximately equal volume production, whereas the 'D/E' grade is decidedly inferior to either in this respect. An increase in thinning intensity, however, accelerates the development of average diameter and pushes up more trees into the upper diameter classes.

INTRODUCTION

1. Our knowledge of the comparative effect of different grades of thinnings on crops of Indian tree species is very meagre. The optimum thinning intensity for a particular species has been a controversial subject: the opinions of the protagonists of different grades being based on their personal interpretations of the fundamental theory of thinning rather than on any factual data. Based on general field observations, the consensus of opinion has been that the light-demanding species like *chir*, sal and teak produce best results with the heavier thinning grades, whereas the comparative shade-bearers are best treated under the lighter grades. The problem of determining the optimum thinning treatments for various species has been excercising the minds of the Indian foresters for quite a long period. The importance of conducting experiments on scientific lines to determine the comparative influence of different thinning types and grades being appreciated, a number of such investigations has been started for the more important of our timber species during the last 25 years or so. As would be expected, the earliest ones out of these were quite simple in design and lay-out and seldom paid attention to the question of adequate number of replications or proper randomization. With the gradual realization of the importance of the application of statistical science to forest research, due regard came to be shown to these principles and the later investigations have tended to be more elaborate in design and lay-out and less vulnerable to criticism from the statistical view-point. The object of this paper is to present an interim report on the results of one of the earliest of these investigations, viz., the set of sample plots number 11, 12 and 13 of Kalimpong Division, West Bengal, laid out in December, 1930 to compare the effect of different grades of thinnings on plantation sal (*Shorea robusta*).

LOCALITY, CLIMATE AND FOREST

2. The 3 plots were selected in the 1926 sal plantations of Sangser Block, Tista Range of Kalimpong Division, West Bengal. The locality is 900 feet above mean sea-level and receives an annual rainfall of 120 inches. The climate, therefore, is hot and humid. The plots being situated on undulating ground the drainage is satisfactory. The parent rock consists of gneissic schist and slate and the resulting soil is a deep, rich loam. The original forest was tropical moist deciduous sal forest [Champion's sub-type 3B/C2–D1 (*a*)] with *Schima wallichii*, *Garuga pinnata*, *Terminalia belerica*, *T. crenulata* and *Stereospermum*

chelonoides as the main associates. The plantation had been raised from line sowings 6 feet apart, after clear-felling the original forest and had received no thinnings till the formation of the plots in December, 1930.

SITE QUALITY

3. The growth of sal plantations in the locality is exceptionally rapid. Yield Tables for plantation sal have not so far been produced, but on the basis of the existing quality classification for natural sal high forest, the site quality inside the plots is about 2 full qualities above the first.

CONDITION OF PLOTS AT THE TIME OF FORMATION

4. The plots adjoin each other on the ground and are square in shape, each being 150 × 150 feet = (0·517 acres) in size. They were fully stocked and on visual examination appeared to be identical from the view-point of soil fertility, topography and crop condition. The crop standing in each plot before thinnings was measured for testing initial comparability and the relative position is illustrated by the following statement.

TABLE 1.—*Comparability of the Plots at the Time of Formation (before thinning)*

Plot No.	No. of stems	Basal area (sq. ft.)	Height		REMARKS
			Crop (feet)	Top (feet)	
11	4536	49·2	19	22	Stems below ½ inch diameter were totally ignored.
12	3801	40·7	19	22	
13	4158	39·8	18	22	
% variation between the maximum and minimum values	16	19	5	0	

5. Whereas the variations in the number of stems and height are within the acceptable limits of 20 and 15 per cent respectively, the difference in the basal area figures deviates considerably from the standard of 10%. If an initial light thinning, which is carried out as a matter of routine in such comparative thinning investigations, had been carried out the differences in respect of number of stems and basal area would have been reduced appreciably. Considering that the site qualities, as judged from top heights, were identical in the beginning and have remained practically so afterwards (c.f., para 9 *infra*), and that the investigation was started in a very young crop, the 3 plots may be safely taken as initially comparable.

TREATMENT

6. The original intention was to study and compare the development of unthinned, lightly thinned and heavily thinned sal (plantation) crops. Plots number 11, 12 and 13 were, therefore, allotted the "no thinning", 'B' grade ordinary thinning and 'D' grade ordinary thinning treatments respectively. The thinning cycle was fixed at 5 years and full crop measurements were to be made along with the thinnings. The first thinning operation in plots 12 and 13 was carried out in December, 1930 at the time of formation. The thinning intensities in the 3 plots were changed to 'C/D', 'D' and 'very heavy D' grades respectively at the time of the second thinnings in January, 1936, presumably because the 'no thinning' and 'B' grade thinning treatments are of little practical value. The treatment has remained unchanged after that. Subsequent thinnings were carried out in February, 1941 and March, 1946. The crops were considered to be still open at the time of the quinquennial inspection in April, 1951. No. trees were felled from plot No. 11 and the thinning operation in plots

12 and 13 amounted only to the removal of 8 and 6 stems respectively. The plots have been maintained as standard sample plots and full measurements have been made at 5-yearly intervals in December, 1930, January, 1936, February, 1941, March, 1946 and April, 1951, i.e., at the ages of 5, 10, 15, 20 and 25 years.

7. A close examination of the details of stems removed in thinnings, as well as the trend of diameter growth, indicates that the 'very heavy D' grade thinnings done in plot 13 lie mid-way between the 'D' and the 'E' grades. For the sake of uniformity and brevity this intensity will be referred to as 'D/E' grade.

COMPUTATION

8. The field data have been computed on the lines laid down in Chapter X of "The Silvicultural Research Code, Vol. 3 – The Tree and Crop Measurement Manual". It might be briefly stated that the diameter/height and diameter/form factor curves obtained from the measurement of a limited number of sample trees are utilized for computing the volumes whereas the values of top and crop height are obtained from the diameter/height curve alone. The treatments being unreplicated, valid statistical tests of the significance cannot be applied.

HEIGHT GROWTH

9. The development of height in the 3 plots during the last 20 years is illustrated by Table 2.

TABLE 2.—*Development of height in the 3 plots*

Plot No.	Thinning intensity since 1936	Height in feet									
		1930		1936		1941		1946		1951	
		Crop	Top	Crop	Top	Crop	Top	Crop	Top	Crop	Top
11	'C/D' grade ..	19	22	35	39	53	61	61	72	74	91
12	'D' grade ..	19	22	37	40	56	61	63	69	79	89
13	'D/E' grade ..	19	22	38	40	56	60	66	71	84	90

It will be readily noticed, that a difference in thinning intensity over a period of 20 years has not given rise to appreciable variation in top height. This, however, is not true of the crop height. The variations in this factor have been progressively increasing : the C/D thinning grade having given the lowest values and the D/E grade the highest.

DIAMETER GROWTH

10. Table 3, below, gives the values of average diameter of the main crop for the three plots at different stages in their life.

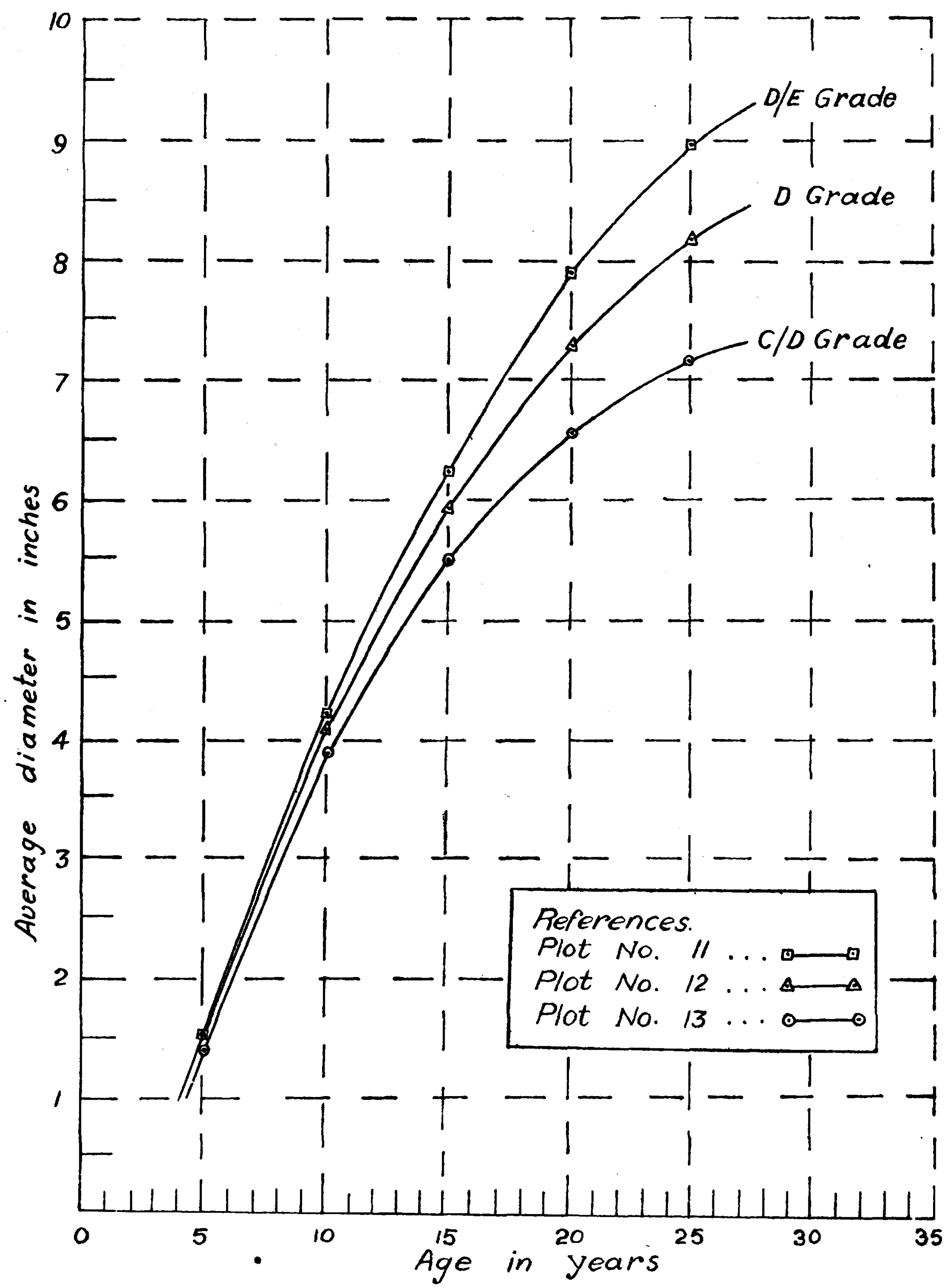
TABLE 3.—*Development of crop diameter in the 3 plots*

Plot No.	Grade of thinnings since 1936	Main crop diameter (in inches) at age				
		5 years	10 years	15 years	20 years	25 years
11	'C/D'	1·4	3·9	5·5	6·6	7·2
12	'D'	1·5	4·1	5·9	7·3	8·2
13	'D/E'	1·5	4·2	6·2	7·9	9·0

As should be expected an increase in the thinning intensity has accelerated diameter increament. The data of table 3 have been utilized for preparing Figure 1. It appears that

Fig. 1

THINNING INTENSITIES AND CROP DIAMETER



crops of this site-quality attain an average diameter of 7 inches at the ages of 17, 19 and 23 years under the 'D/E', 'D' and 'C/D' grades respectively. The trends of these curves indicate that these differences would increase progressively for higher values of crop diameter.

NUMBER OF STEMS PER ACRE AND THEIR DISTRIBUTION BY DIAMETER CLASSES

11. Table 4 shows the number of stems per acre in each plot before thinning on different dates and the distribution of these stems by diameter classes.

TABLE 4.—*Distribution of stems by diameter classes*

Date / Age of crop	Diameter class	No. of stems per acre before thinnings		
		Plot No. 11	Plot No. 12	Plot No. 13
December, 1930 / 5 years	3"	37	38	33
	2"	1391	1107	949
	1"	3108	2656	3176
	TOTAL	4536	3801	4158
January, 1936 / 10 years	6"	13	9	6
	5"	119	124	103
	4"	437	372	334
	3"	661	481	467
	2"	1042	786	533
	1"	543	215	139
	TOTAL	2815	1987	1582
February, 1941 / 15 years	9"	2	1	..
	8"	10	15	10
	7"	58	69	72
	6"	152	150	131
	5"	232	162	90
	4"	225	84	34
	3"	95	24	3
	TOTAL	774	505	340
March, 1946 / 20 years	11"	1	1	..
	10"	9	7	8
	9"	33	40	39
	8"	50	53	77
	7"	111	97	61
	6"	134	83	14
	5"	127	41	5
	4"	39	2	1
	3"	2	3	..
	TOTAL	506	327	205
April, 1951 / 25 years	13"	1	..	..
	12"	3	5	2
	11"	14	16	22
	10"	26	30	43
	9"	37	45	51
	8"	63	59	39
	7"	73	62	23
	6"	71	28	5
	5"	85	16	1
	4"	30	1	..
	3"	..	3	..
	TOTAL	403	265	186

12. Frequency polygons in Figures 2 and 3 give a visual representation of the diameter distributions in the three plots in 1936 and 1951.

13. It may be noted that whereas in 1930 and 1936 the number of stems in the upper diameter classes in plot 13 wes less than in plot 11 or plot 12 and the number in the latter two was more or less equal, the picture has been completely changed by 1951 when the number of stems in the top diameter classes (say 10 inches and over) was the maximum in plot 13, the next one in this respect being plot 12, and plot 11 coming last of all. The over-all influence of the heavier grades of thinnings in this case, therefore, has been to push up more trees into the upper diameter classes.

BASAL AREA INCREMENT

14. As already mentioned, the final thinning treatments in the 3 plots were started in January, 1936. Comparison of basal area growth would, therefore, be justified after that date only. The basal area after thinnings in 1936, the total basal area in 1951 and the basal area removed in thinnings during the period are given in Table 5. The total periodic increment for the 15 growing seasons and the mean annual periodic increment have been calculated. The absolute basal area increments fall regularly with a rise in thinning intensity. The basal area increment %, which gives a picture of the returns on basal area left in the field, however, shows the opposite trend.

TABLE 5.—*Growth of Basal Area during the period January, 1936 to April, 1951*
(10 to 25 years age)

Plot No.	B.A. after thinnings in Jan., 1936 (s. ft.)	Total B.A. in April, 1951 (s. ft.)	B.A. removed in thinnings 1941 and 1946 (s. ft.)	Total periodic increment (3 + 4 − 2) (s. ft.)	Mean annual periodic increment (s. ft.)	
					Absolute	%
1	2	3	4	5	6	7
11	63·1	112·3	41·1	90·3	6·02	9·5
12	46·2	95·6	33·2	82·6	5·51	11·9
13	32·0	82·9	26·1	77·0	5·13	16·0

VOLUME INCREMENT

15. For reasons already recorded in para 14, a comparison of volume growth is feasible only for the period 1936 to 1951 during the course of which the three plots have remained under consistent thinning treatments. The total volume growth in each plot for these 15 years as well as the values of mean annual periodic volume increment are shown in Table 6.

16. Maximum production of total volume has been obtained with the 'C/D' grade thinnings and the figures exhibit a regular fall with a rise in the intensity of thinnings. Whereas the difference between the performances of the 'C/D' and 'D' grades is comparatively small, there is a sharp fall under the 'D/E' grade. The stem timber and smallwood production figures show no regular sequence. The stem timber growth is maximum under the 'C/D' grade and minimum under the 'D' grade. As the difference between the 'C/D' and 'D/E' grade treatments is small, it is felt that the exceptionally low production under the 'D' grade thinnings is a matter of chance and with a larger number of replications the differences between the three will tend to even out. The smallwood production is more or less equal under the 'C/D' and 'D' grade thinnings, but it is distinctly poorer under the 'D/E' grade. Thus it

Fig. 2

DISTRIBUTION OF STEMS BY DIAMETER CLASSES
JAN. 1936

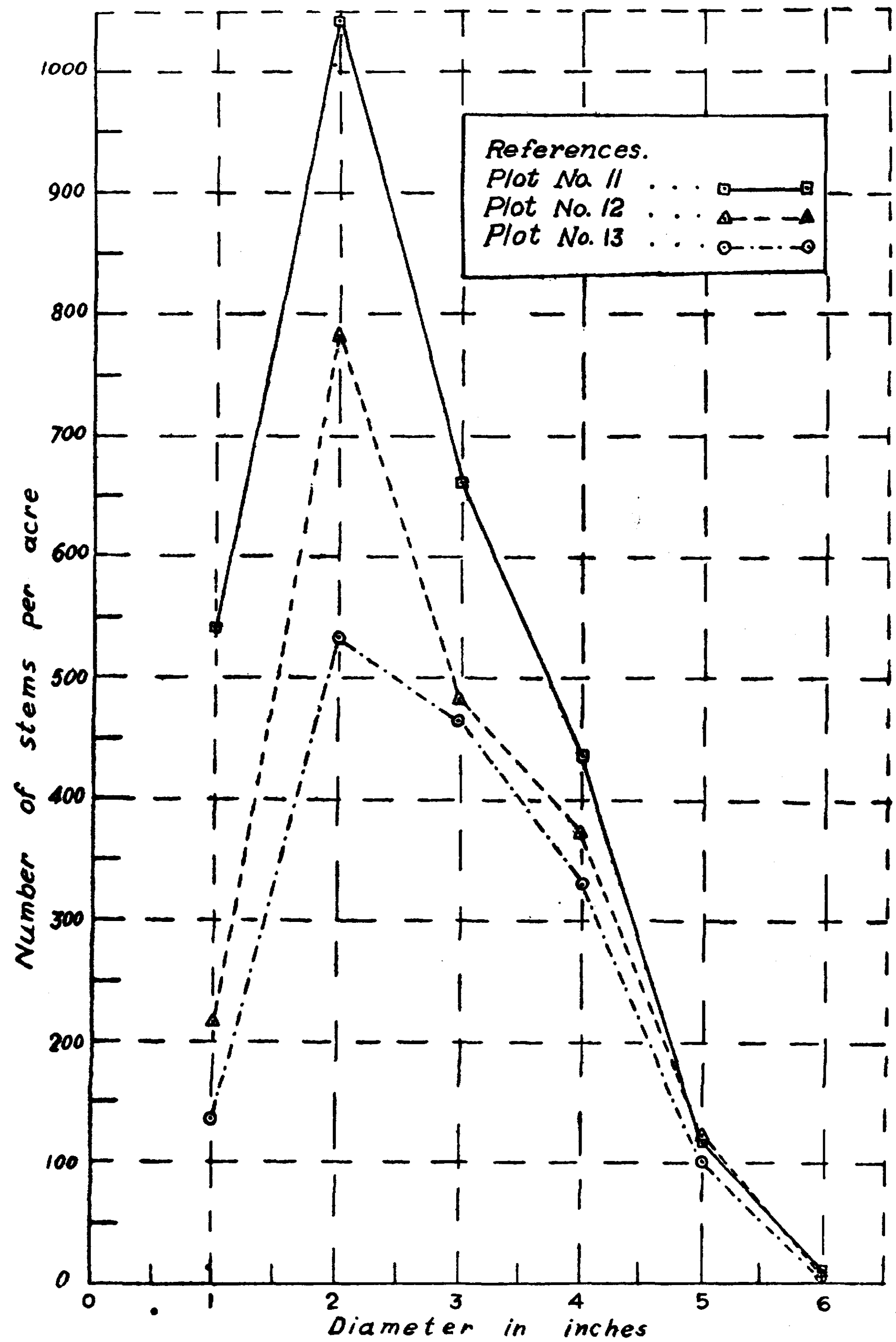


Fig. 3

DISTRIBUTION OF STEMS BY DIAMETER CLASSES
APRIL-1951

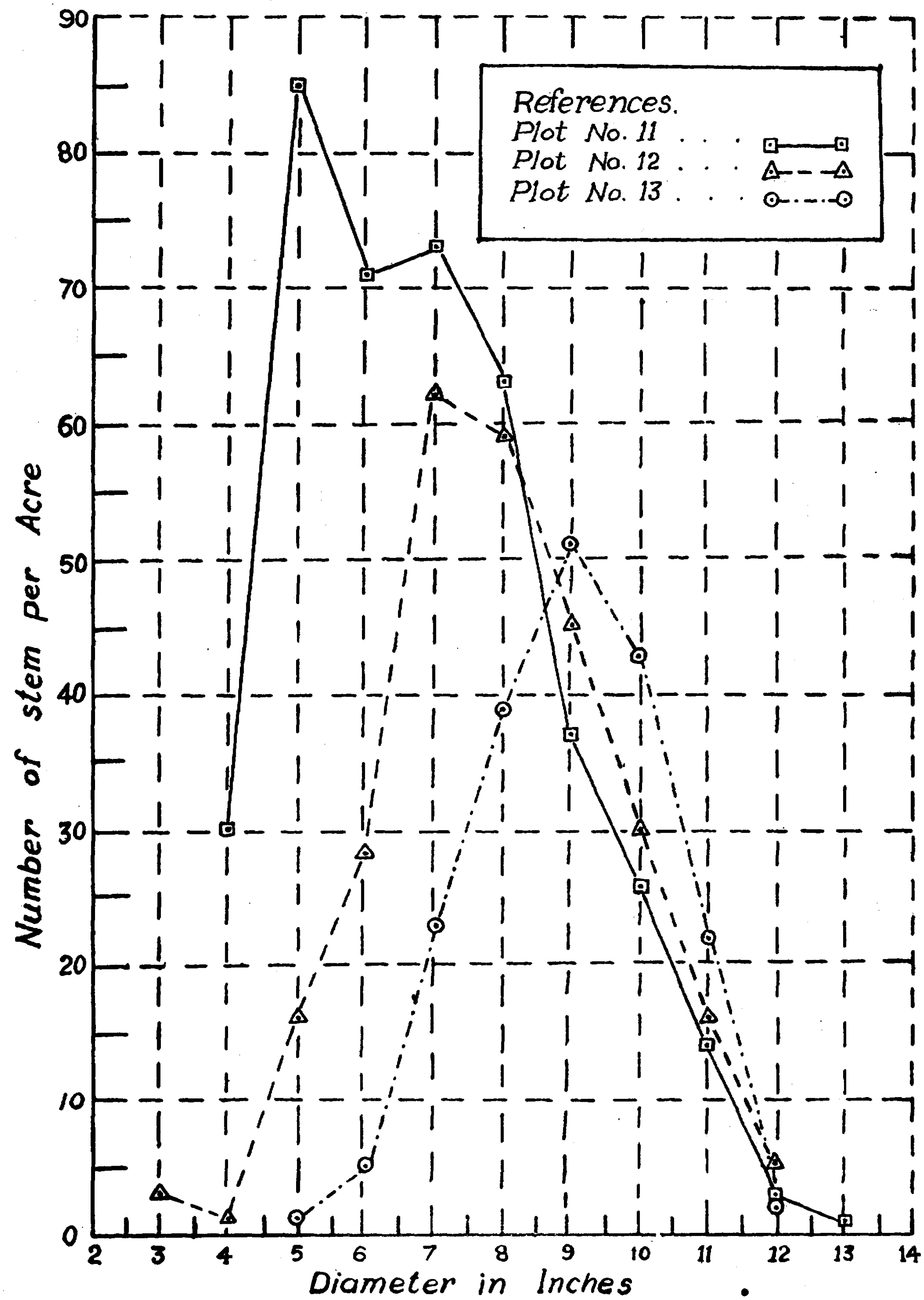


TABLE 6.—*Growth of Volume during the period January, 1936 to April, 1951 (10 to 25 years age)*

Plot No.	Volume of Main Crop (c. ft.) Jan., 1936			Volume of Total Crop (c. ft.) April, 1951			Volume removed as thinnings 1941 and 1946 (c. ft.)			Total periodic increment for 15 years (c. ft.)			Mean annual increment for the period			
	Stem* timber	Stem† smallwood	Total	Stem* timber	Stem† smallwood	Total	Stem* timber	Stem† smallwood	Total	Stem* timber	Stem† smallwood	Total	Stem* timber (c. ft.)	Stem† smallwood (c. ft.)	Total Absolute (c.ft.)	Total %
11 (C/D grade Thinnings)	0	1019	1019	931	2425	3356	0	802	802	931	2208	3139	62	147	209	20·5
12 (D grade Thinnings)	0	750	750	793	2244	3037	0	765	765	793	2259	3052	53	151	203	27·1
13 (D/E grade Thinnings)	0	531	531	900	1282	2182	0	627	627	900	1378	2278	60	92	152	28·6

* Volume of the main bole, including stump but excluding bark down to the limiting diameter of 8 inches over bark.

† Volume of the main bole, including bark, between the limiting diameters of 8 inches and 2 inches over bark.

appears that maximum volume production (stem timber plus stem smallwood) is obtained under the 'C/D' grade. This production does not materially go down under the 'D' grade of thinnings. With the heavier 'D/E' grade there is a sharp decline in the total volume production though the stem timber increment remains more or less unaffected.

THINNING CYCLE

17. Experience gained in this investigation suggests that high quality sal plantations should be thinned every 5 years up to an age of 20 years and that the thinning interval will have to be increased thereafter.

GENERAL COMMENTS

18. As is apparent from the above description, this investigation is not perfect from the point of view of experimental design and lay-out and subsequent execution. A valid test of significance of the differences cannot be applied in the absence of an adequate number of replications. The initial choice of the treatments was not the happiest and these had to be changed after 5 years. These drawbacks are mitigated to some extent by the remarkable uniformity of site quality between the 3 plots and the fact that the treatments were started at an early age. The plots have already been in existence for a period of 20 years and are well worth maintaining up to the rotation age.

CONCLUSIONS

19. The investigation indicates that in the case of top quality young sal plantations an increase in thinning intensity accelerates the development of average diameter and pushes up more trees into the upper diameter classes. Within the limits of the 'C/D' and 'D/E' grades of ordinary thinnings, investigated in the present case, the basal area growth falls regularly with a rise in thinning intensity. The maximum production of total volume is obtained under the 'C/D' grade, though the 'D' grade is not much behind it. The 'D/E' grade gives much inferior results both from the view-point of basal area increment and total volume production. Its performance from the point of view of stem timber production is practically as good as that of the 'C/D' grade. This latter treatment appears to be the best of the three for the production of fuel and stem timber. It is felt that the investigation will have to be continued much longer before the superiority of any particular grade from the point of view of large timber could be finally established.

ACKNOWLEDGEMENTS

Grateful thanks are due to Shri V. S. Krishnaswamy, I.F.S., Central Silviculturist, Forest Research Institute, Dehra Dun for his very kindly going through the rough draft and offering valuable suggestions. The author also acknowledges the help rendered by Shri B. M. Bhattacharya, Lower Assistant and Shri S. N. Mitra, Computer in carrying out the routine computations and preparing the tabular statements and diagrams.

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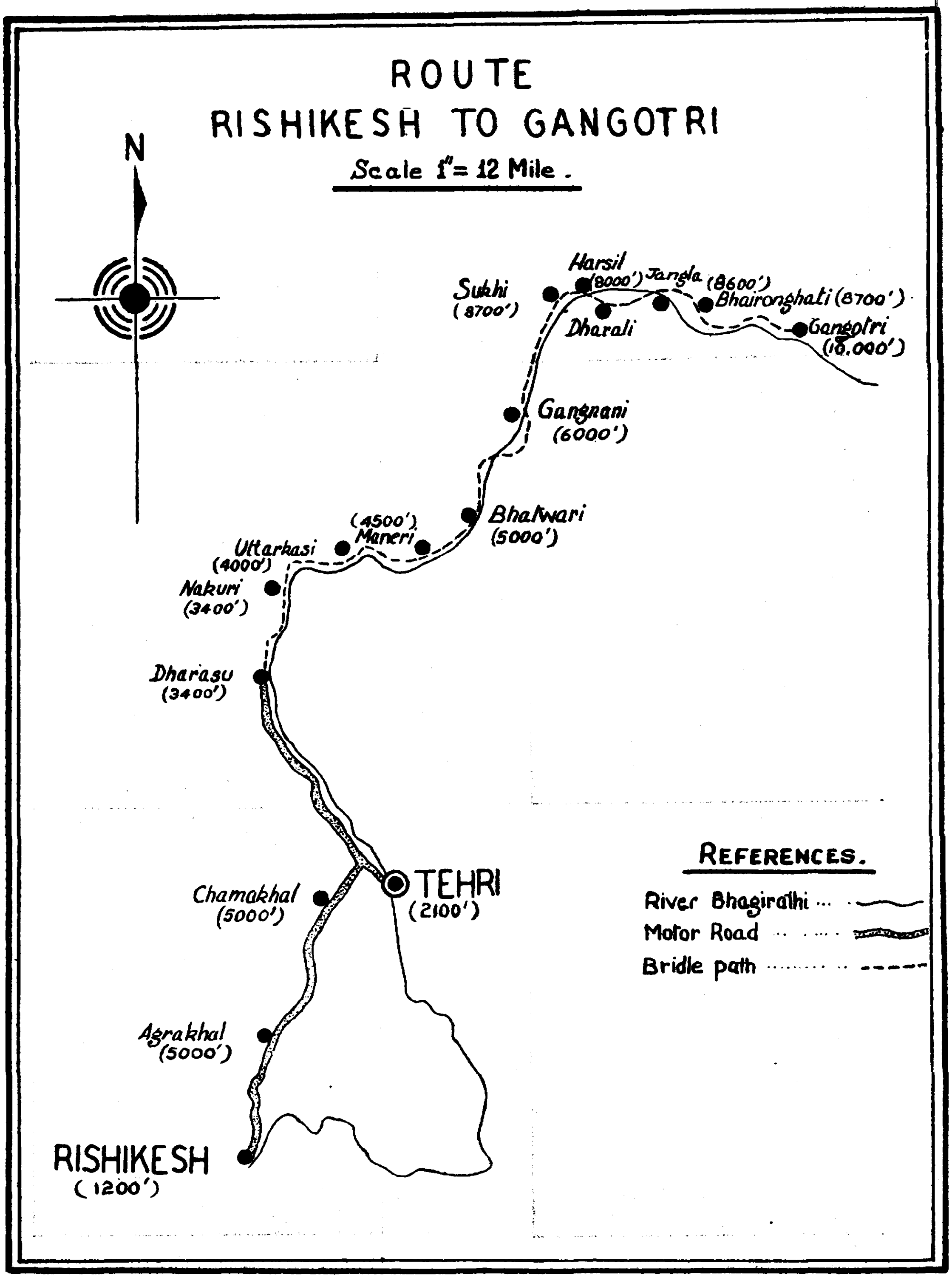
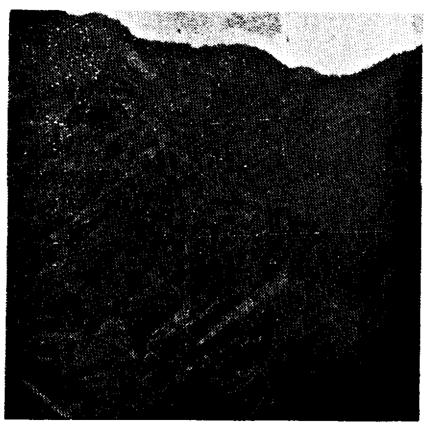

ROUTE
RISHIKESH TO GANGOTRI
Scale 1" = 12 Mile.
N
Harsil
(8000')
Jangla
(8600')
Sukhi
(8700')
Bhaironghati (8700')
Dharali
Gangotri
(10,000')
Gangnani
(6000')
(4500')
Maneri
Bhatwari
(5000')
Uttarkasi
(4000')
Nakuri
(3400')
Dharasu
(3400')
REFERENCES.
River Bhagirathi
Motor Road
Bridle path
Chamakhal
(5000')
TEHRI
(2100')
Agrakhal
(5000')
RISHIKESH
(1200')

Rocky and narrow path with over-hanging cliffs and rocky steps.

Goats and sheep carrying provisions.



Forests on the hill slopes.

Cultivation in the Valley.

Forests and cultivation on the hill slopes.

Consequent erosion and destruction of filds.

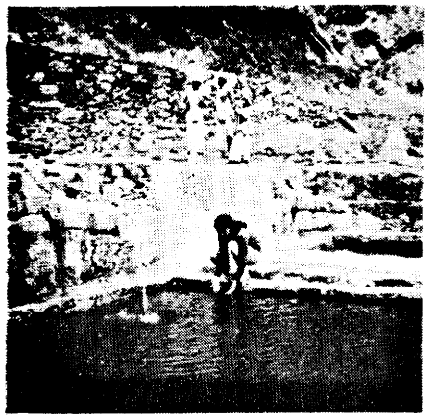
Vishwanath Ji Temple at Uttarkashi.

Poorly wooded hills between Maneri and Bhatwari.

Temple at Bhatwari.

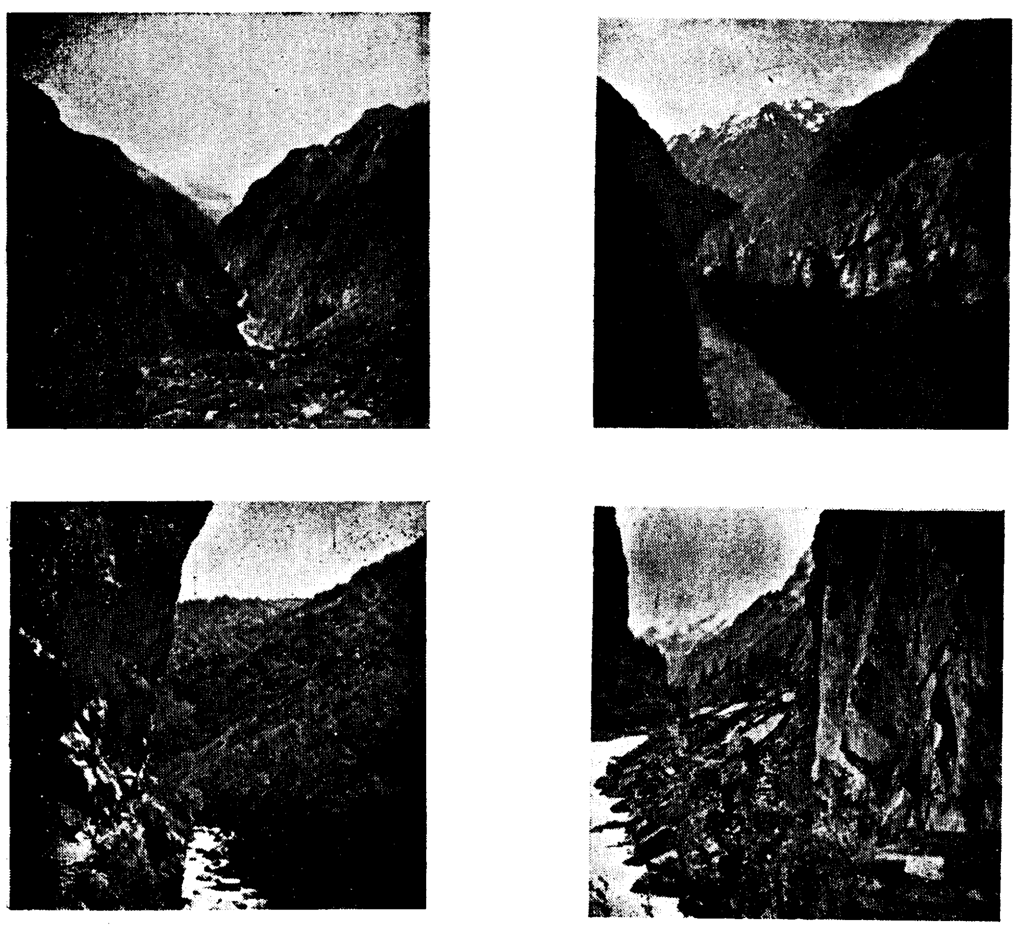
Suspension bridge between Bhatwari and Gangnani.

Waterfalls.



Hot Sulphur water tanks -- Gangnani
(a boon to the tired).

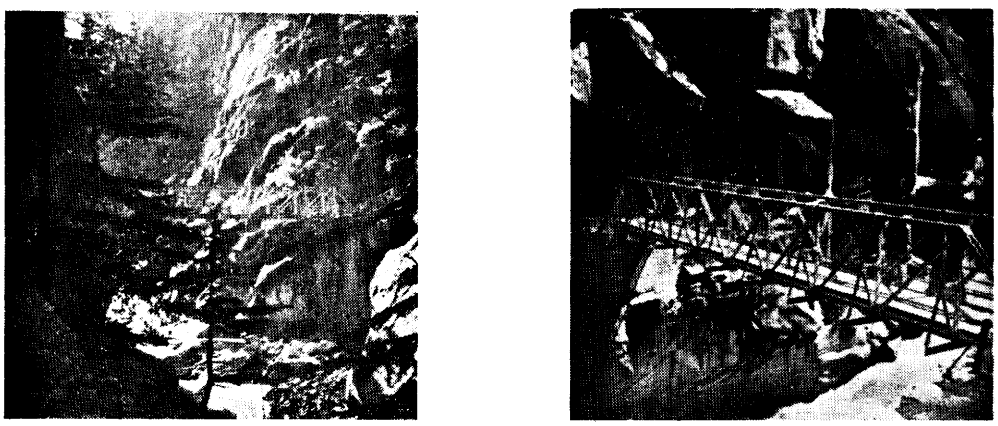
Loaded mules along the descent from
Sukhi towards Harsil.



The narrow **Bhagirathi** Valley.

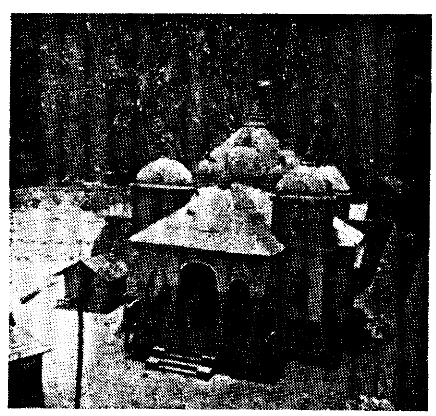
Harsil F.R.H.

Apple orchard.

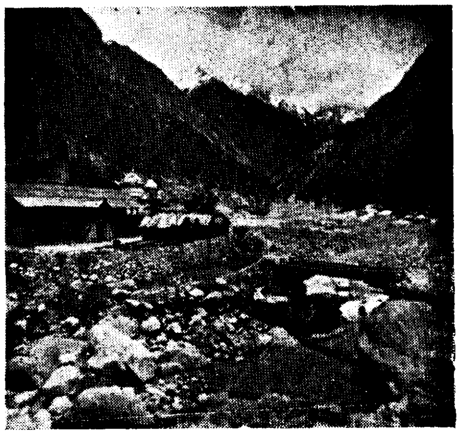


Girder bridge across Bhaironghati gorge.

The temple at Dharali 2/3 under the debris.



Gangotri Temple.


Bridge at Gangotri.

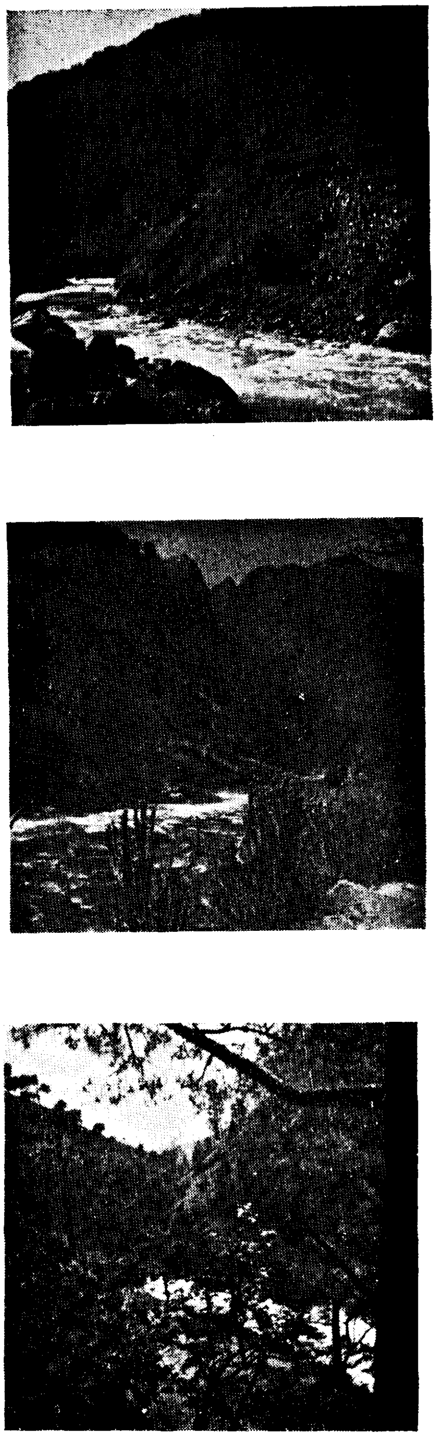

Difficult path to Gaumukh, beyond Gangotri.



Difficult path to Gaumukh, beyond Gangotri.


Natural earth bridge due to avalanche.

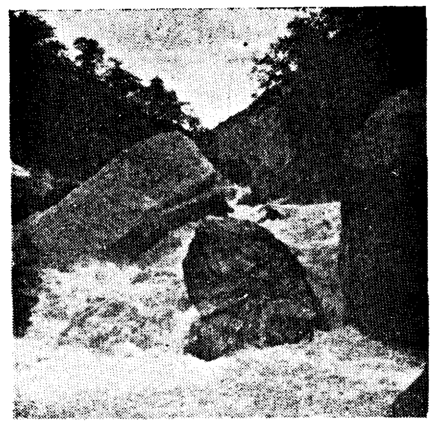

Scrub miscellaneous forests between Dharasu and Maneri.



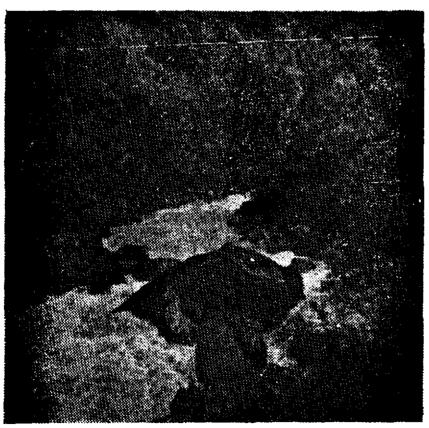
Chir forests along the hill slopes.

Deodar forests between Harsil and Gangotri.

Birch forests.



Obstructions in the bed of the Bhagirathi river.



Obstructions in the bed of the Bhagirathi river.

THE REDWOOD OF CHINA

(Metasequoia glyptostroboides Hu et Cheng)

BY M. B. RAIZADA
Forest Research Institute, Dehra Dun

Much publicity has been given in the scientific and popular press to the recent discovery in China of a coniferous tree belonging to a genus, which was considered to have become extinct some 20,000,000 years ago and was previously known only from fossil records dating back to Mesozoic times, when the animal life of the globe was dominated by the long - extinct giant reptiles. This refers to the redwood of China, *Metasequoia*, with only one living species, *M. glyptostroboides* Hu et Cheng.

This remarkable discovery has aroused considerable interest, especially in botanical and forestry circles for more than one reason. A new type of conifer is rarely found now-a-days in the living forest vegetation of the north temperate zone. *Metasequoia* is moreover a tall tree which has been known to the natives for more than two centuries. Further, it is closely related to the giant redwood of California, *Sequoia sempervirens* (Lamb.) Endl., and has for this reason also, attracted particular attention. Nevertheless, the publicity around *Metasequoia* would hardly have reached its present extent, were it not for the fact that just a few years before the rediscovery of the living species the genus had been recognized on fossil remains of Tertiary age found in Eastern Asia and in the Arctic. Consequently, it was immediately realized that *M. glyptostroboides* is a relict of an ancient genus of the Arcto-Tertiary flora, like the more or less closely related *Sequoia, Glyptostrobus* and *Taxodium.*

THE DISCOVERY OF THE LIVING METASEQUOIA

At the end of 1941, T. Kan of the National Central University, Nanking, China, travelled in the border land of eastern Szechuan and western Hupeh in Central China. At the village Mo-tao-chi, situated about south-east of Wan-hsien and about 140 miles north-east of Chungking, he met with a peculiar deciduous tree called by the natives 'Shui-hsa' meaning water fir or water larch. Owing to the season, nomaterial was collected. In the summer of 1944, T. Wang, attached to the Bureau of Forestry, Nanking, travelled in the same area and brought back specimens of needles and cones which he had collected at the village of Mo-tao-chi. This material was studied by W. C. Cheng, Professor of Forestry at National Central University, Nanking, and H. H. Hu, Director of the Fan Memorial Institute of Biology, Peiping, both of whom have a very wide knowledge of the living plants of China. They soon realized that it represented no living tree and comparisons showed that the cones and leafy shoots were essentially the same as those described by Miki from fossil specimens in Japan. In 1946 two more expeditions were sent out by Cheng under the leadership of C. P. Hsueh, one of his assistants, who found 25 trees in all of the new conifers and brought home a much richer herbarium material than Wang had done. Specimens from this collection were subsequently sent to the Arnold Arboretum of Harvard University, whose director at that time, Dr. E. D. Merrill, became keenly interested to obtain seed for propagation. With financial support provided by the Arnold Arboretum, through the co-operation of Dr. Merrill and with a small grant from the University of California, Cheng organized in 1947 a third expedition to the borderland of eastern Szechuan and Western Hupeh, in which besides Hsueh also C. T. Hwa, a student of Cheng, took part. During this expedition a hundred or so large trees, of which some were planted, were found growing on slopes, along streams, and near rice paddies and scattered over a fairly large area (500 square miles). The centre of distribution was in the Shui-hsa valley in Hupeh, where at least 1,000 trees, including small specimens, were found growing. During this expedition besides herbarium material, an ample supply of viable seed was also

collected. Samples of seed were then distributed by Cheng and Merrill to a large number of botanical gardens and interested research workers in and outside China. With adequate material for study at hand, Hu and Cheng have recently published [Bull. Fan. Mem. Inst. Biol. 1 (1948) 153–161] an illustrated account of this new tree, under the name of *Metasequoia glyptostroboides*.

BOTANICAL DISCRIPTION

Tree up to 50 m. tall, with a tapering trunk usually strongly buttressed at the base, pyramidal when young, in old age with a broad spreading crown. Bark dark grey, fissured, exfoliating in thin plates when young exposing the purplish-brown inner bark beneath, peeling off in long threads in old age ; branchlets opposite, glabrous, smooth, green when young becoming brownish later and changing to brownish-grey or grey in the second or third year ; lateral foliage shoot deciduous in winter, glabrous, opposite, up to 7 cm. long, distichously arranged, with persistent bracts at the base, without terminal or axillary buds. Winter buds ovoid or ellipsoid, obtuse, 4 mm. long, 3 mm. across, glabrous, bracts decussate, 12–16, broad-ovate, rounded or obtuse at the apex, 2–2·5 mm. high and broad, yellowish-brown, paler and thinner on the margin, lustrous and longitudinally keeled on the back. Leaves deciduous, opposite, distichously arranged in two ranks, linear, 8–15 mm. long, 1·2 mm. broad at the middle, broader towards the base, sessile or nearly sessile, mid-rib elevated on both sides, bluish-green above, light green and with 4–6 rows of stomata on each side below. Flowers monoecious, solitary, glabrous, Male strobili axillary, short-stiped when ripe, decussate on long spike-like or paniculate shoot systems, and each protected by about 14 basal decussate, triangular-ovate or obovate cataphylls ; strobili generally solitary, but occasionally two tangentially placed strobili occur in the same axil. Microsporophylls 15–20, not strictly decussate, 1–1·2 mm. long, 1 mm. broad, with 3 – or in the uppermost and lowermost sporophylls 2 – pollen sacs attached to the abaxial surface below the laminate tip, dehiscing longitudinally. Female conelets on specialized branchlets, arising singly in leaf axils and each enclosed by 14–16 decussate cataphylls, which are coriaceous, glabrous, triangular-ovate, obtuse at their apices, and keeled on their abaxial sides. Small decussate, linear oblong or linear foliage leaves are interpolated between the cataphylls and the conelet. Conelet oblong-ellipsoid, composed of up to about 20–30 decussate, ovate cone scales, each with a broad stalk-like portion, an apex broadly angled in tangential view, and a large distal resin cavity. The lowermost 2 or 3 infertile pairs of cone scales are followed by about 8 pairs of ovule-bearing scales, the uppermost 3 pairs are sterile. Ovules erect 5–9 to each scale, the lowest and uppermost scale sterile, the lower one, bearing 9 ovules, the middle ones 7, and upper ones 5. Cones ripening in the first year, pendulous, subquardrangular-globose or shortly cylindric, 18–25 mm. long, 16–23 mm. across, dark brown. Mature cone scales woody, decussate, mostly 22–24, sometimes 28, peltate, dilated from a wedge-shaped base into a transversely elliptic or triangular disk with a transverse median depression, 7–9 mm. high, 18–21 mm. across at the upper disk ; peduncles glabrous, terete, green when young, becoming light brown or brown later, with decussate, linear leaves before maturity, and with conspicuous leafscars and with persistent bracts at the base in winter. Seeds usually 5–9 on each cone scale, of buff colour, seed-wing all round, compressed, usually obovate, notched at the apex, 5 mm. long, 4 mm. broad. Cotyledons 2.

GEOGRAPHICAL DISTRIBUTION AND ECOLOGY

According to Hu and Cheng the *Metasequoia* region on the border between Szechuan and Hupeh has an area of approximately 500 square miles ranging in altitude from 700 to 1,350 m. above sea-level. Herbarium material has been collected in the following localities :

China : E. Szechuan, Wan-hsien district, Mo-tao-chi, road side, by stream, 1,100 m. S.W. Hupeh, Li-chuan-hsien, Houng-pan-ching, by stream, 1,300 m. ; Jao-yu-tai, near Wang-chia-ying, on open slope, 1,200 m. ; Shui-hsa-pa in Shui-hsa valley alt. 900–1,350 m.

Chu and Cooper mention that *Metasequoia* occurs as a constituent of a presumably natural and actively reproducing forest community only in a limited area of the Shui-hsa valley forming about 15½ miles long and about a mile wide strip along the main river. It decreases in frequency outwards in all directions from this distribution centre, but scattered trees, some of considerable size, occur for a distance of no less than 25 miles from Shui-hsa-pa toward Mo-tao-chi, which indicates that the natural *Metasequoia* community was at one time more wide spread. It thrives best along rocky banks of small streams and at the foot of the slopes in association with trees (viz., *Cunninghamia lanceolata*, *Cephalotaxus fortunei*, *Taxus speciosa*, *Castanea sequinii*, *Lequidambar formosana*, etc.), shrubs (viz., *Spiræa*, *Hydrangea*, *Viburnum*, *Berberis*, *Contoneaster*, etc.) and woody lianas (viz., *Hedera*, *Rosa*, *Rubus*, *Akebia*, *Holbœllia* and *Schisandra*), forming a dense thicket-like growth. Hu states that the natives frequently dig up young trees for planting along rice fields or streams or round their houses.

RELATIONSHIP

The relationships and systematic position of *Metasequoia* have been repeatedly discussed by various authors (Stebbins, Hu and Cheng, Teng, Chaney, etc.). There is general agreement on the taxodiaceous affinities of the genus, notwithstanding the decussate arrangement of its foliage leaves and cataphylls, male strobili and cone scales, by which it differs from all other members of the family and to some extent resembles the *Cupressaceæ*. In the opinion of Hu and Cheng this should justify the designation of a separate family, the *Metasequoiaceæ*.

Stebbins compared 27 selected characters of the living representatives of *Metasequoia*, *Sequoia*, *Sequoiadendron*, *Taxodium* and *Glyptostrobus* and found that *Metasequoia* resembles *Sequoia* in no less than 18 of these. *Sequoia* in its turn is said to be nearest to *Sequoiadendron* although the differences are more numerous than between *Sequoia* and *Metasequoia*. *Glyptostrobus* and *Taxodium* are regarded as not being more closely related to *Metasequoia* than is indicated by the placing of all these genera in the same family. The diploid *Metasequoia* ($2n = 22$) might in Stebbin's opinion be one of the early Tertiary or Mesozoic parents of the hexaploid *Sequoia sempervirens* ($2n = 66$). On account of its small pollen grains *Metasequoia* is regarded as possibly the most primitive genus of the *Taxodiaceæ*.

As regards the male strobili, *Metasequoia* resembles *Taxodium* in their arrangement, but in the number of pollen sacs to each sporophyll these genera differ, and the former is again closer to *Sequoia*. The type of pollen grain found in *Metasequoia* is quite similar to that characterizing several genera of *Taxodiaceæ*, and does not occur outside this family. Like *Taxodium* and *Glyptostrobus*, *Metasequoia* has persistent long shoots and deciduous short shoots, but in contradistinction to the former genera the latter has exclusively flat, linear, needle-like foliage leaves, and differs moreover from all previously known genera of the *Taxodiaceæ* in the epidermal structure of the leaves. *Metasequoia* has distinct cataphylls round its winter buds, which *Sequoia* has not. In the anatomy of stem wood, on the other hand, they resemble each other to a great extent.

Metasequoia evidently behaves in about the same way as all other genra of the *Taxodiaceæ* with surviving species. It resembles several of these genera, particularly *Sequoia*, but at the same time it differs distinctly in quite a few features from any one of them. Its combination of characteristics is thus unique, though evidently not in the sense of justifying the erection of a new family. The case of *Metasequoia* strengthens the view that the surviving members of the family *Taxodiaceæ*, nearly half of which represent monotypic genera and all occupy more or less restricted uniregional areas, constitute isolated remnants of a Mesozoic group of conifers, richly developed and widely distributed particularly in the Northern Hemisphere. They are to all appearance end members of separate lines of development, whose common ancestry has been obscured by time.

EXPLANATION OF PLATE

1. A fruiting branch showing leaves and young strobili (Natural size).
2. A long shoot with clusters of male strobili (Nat. size).
3. A male strobilus × 5.
4 and 5. Microsporophylls × 10.
6. A female cone (Nat. size).
7. Seed × 3.

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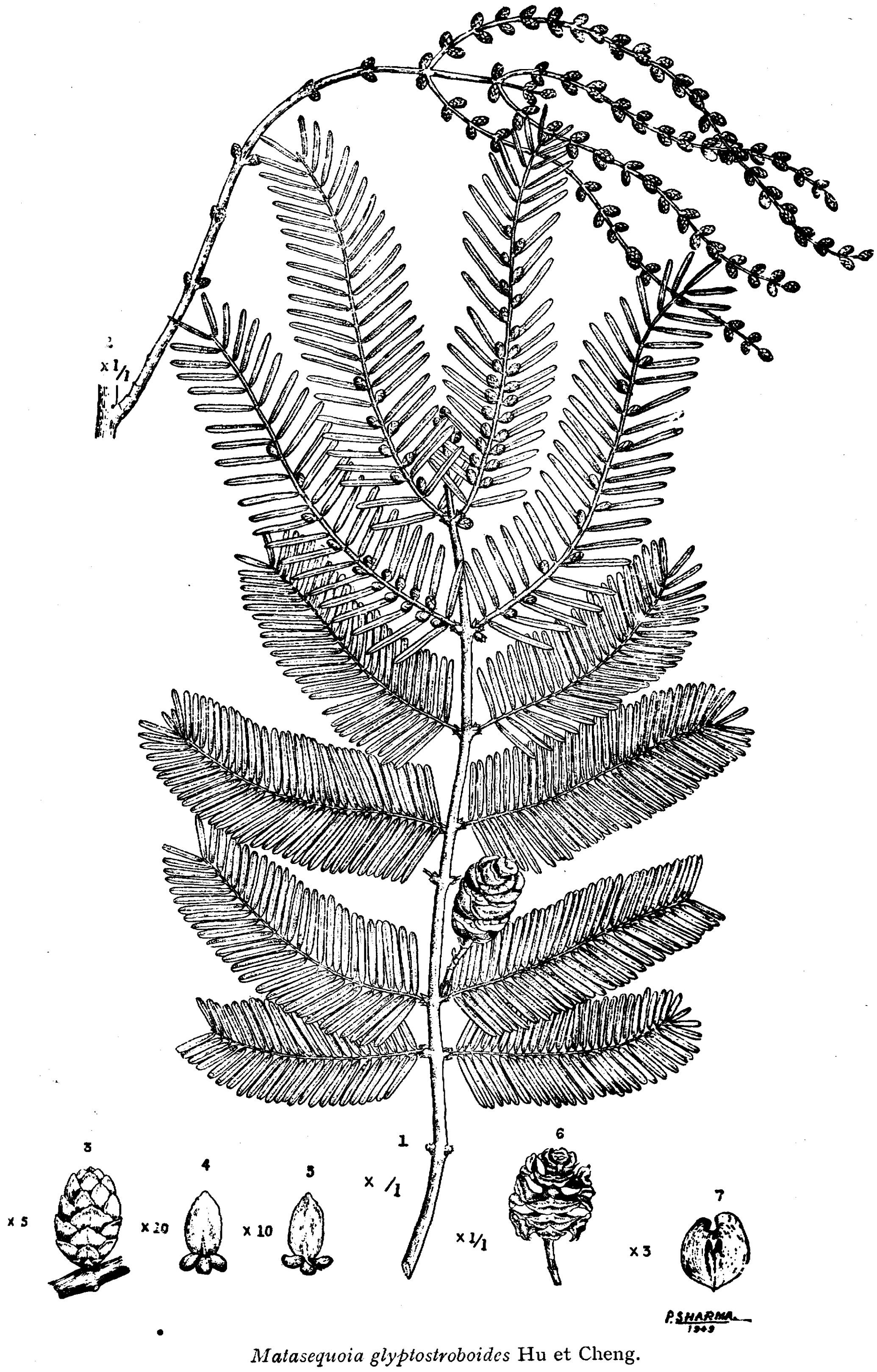

Matasequoia glyptostroboides Hu et Cheng.

THE CULTIVATION OF BALSA (*OCHROMA LAGOPUS S.W.*)

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I. GENERAL

1. Known from very ancient times – long before the discovery of the American Continent – Balsa wood, popularly called the "West Indian Cork Wood", did not gain any commercial importance before the first world war. The extreme buoyancy and lightness of the wood was known to the Incas of Peru and the Red Indians, and Balsa logs were made into rafts not only for fishing but also for short sea voyages. However, it was not until the end of 1915, when there was an acute scarcity and great demand for Cork that Balsa wood began to be more widely known and used ; first as an excellent substitute for Cork and afterwards for various industrial purposes. During the first world war, Balsa wood was largely used in life belts, refrigerator insulation, packing for armour plates in battle ships, in sound and heat proofing and as a vibration insulator in machinery. In the famous 250-mile submarine mine barrage in the North Sea, 80,000 Balsa floats were used, saving thousands of tons of British shipping and valuable Cargo. On account of its extra-ordinary properties, Balsa wood gained great prominence and became an important stratagic war material during the second world war and was put to numerous uses, the most important being the sandwiching and stream-lining of aeroplane parts. In the construction of the famous 'Mosquito Bombers' of Britain, which finally turned the tide of the War, Balsa wood was liberally used. During the post-war period, besides the construction of aeroplanes and gliders, Balsa wood is used in heat and sound insulation, novelties, toys, sea sleds, floats and diaphrams for loud speakers. Due to its tastelessness and absence of any injurious properties, it might be used as an excellent substitute for cork tips in the Cigarette industry. In short, Balsa has a very bright and promising future.

II. INTRODUCTION OF BALSA INTO SOUTH INDIA

2. Balsa is indigenous to tropical America and is distributed from the West Indies and Southern Mexico, to Bolivia and Peru in South America. The bulk of the world supplies now comes from Eucador. Although the tree was introduced into the Royal Botanic Gardens, Calcutta, as early as 1873, it was only in 1935 that the species was first tried in South India from seeds supplied by the Central Silviculturist. Since then, numerous experiments have been conducted to study its silvicultural requirements and characters and having collected valuable data, the Madras Forest Department has started large scale cultivation of Balsa since 1950.

III. BOTANICAL DESCRIPTION

3. *Ochroma lagopus* belongs to the order *Bombacaceæ* and is a medium sized tree attaining a height of 55–60 feet and girth of 5–6 feet in 10–12 years. "The leaves are simple, cordate, very large (6–12 inches long and 5–8 inches in diameter) usually lobed and stellate-pubescent. The petiole is long – 6 to 8 inches and ¼ to ½ inch thick. Flowers 5 to 6 inches long stalked and at the ends of branches ; Calyx five lobed, lobes unequal. Petals 5 to 6 inches long, pale reddish, yellowish or whitish ; staminal tube shortly five lobed at apex, covered from the middle to the apex with adnate anthers ; anthers one celled, cohering, more or less spirally twisted. Ovary conical, 5 sided ; style cylindrical, 5 sided, enclosed in tube of the filaments ; stigmas 5, protruding beyond the anthers, spirally twisted and furrowed, about one inch long. Capsule elongated 5 valved about 5 to 7 inches long and covered inside with

cottony floss ; at maturity the outer cover falls off and the floss expands and looks somewhat like a hare's foot. Seeds many, enveloped in silky cotton like fibres of a pale reddish or chocolate colour. The word *Ochroma* is derived from the Greek word for paleness (especially pale yellowishness) and refers to the colour of the flowers and hair with seeds. The specific name *lagopus* refers to the resemblance of the long, hairy fruit to a rabbit's foot''.

IV. LOCALITIES TRIED

4. In Madras, Balsa has been tried in the following centres :—

(*a*) Sriharikotta—Nellore District (East Coast) – Soil : Sea sand ; annual rainfall 30–40 inches, mostly from the North-East monsoon ; Maximum summer temperature 108°F. and minimum temperature 70°F.

(*b*) Denkanikota—Salem District – Elevation 2,500–3,000 feet above sea-level ; soil : sandy red loam ; rainfall 30–40 inches, mainly from North-East monsoon ; Temperature varying from 90°F. in summer to 55°F. in winter.

(*c*) Begur—Malabar District – (West Coast) ; Elevation 2,400 feet above sea-level ; Soil : dark clayey loam ; rainfall varying from 60–80 inches from South-West and North-East monsoons ; temperature varying from 100°F. in summer to 60°F. in winter.

(*d*) Chandanathode—Malabar District – Elevation 2,500–3,000 feet – Soil : alluvial loam ; rainfall 250–300 inches per annum, mainly from the South-West monsoon ; temperature varying from 80°F. in summer to 54°F. in winter.

(*e*) Kannoth—Malabar District – Elevation 1,000 to 1,500 feet ; Soil : alluvial loam to sandy loam ; rainfall 120 to 170 inches from the South-West and North-East monsoons ; temperature varying from 95°F. in summer to 70°F. in winter ; damp and humid throughout the year.

(*f*) Nilambur—Malabar District – Elevation 300–500 feet : Soil ; alluvial loam to red lateritic loam ; rainfall 90 to 100 inches per annum, mostly from the South-West monsoon ; temperature varying from 100°F. in summer to 70°F. in winter.

(*g*) Dhoni—Malabar District – Elevation 500–1,000 feet ; Soil : red lateritic loam to sandy loam ; rainfall 90 to 120 inches, mainly from the South-West monsoon ; temperature varying from 100°F. in summer to 70°F. in winter.

(*h*) Mount Stuart—Coimbatore District – Elevation 2,500–3,000 feet ; Soil : dark clayey loam ; rainfall 60 to 80 inches, mostly from the South-West monsoon ; temperature varying from 90°F. in April to 60°F. in December and January.

In 1947, the author supplied seeds to the Madras Agricultural Department and trials were made in a few centres. The latest reports are that Balsa is growing well in two centres.

V. SILVICULTURAL REQUIREMENTS AND CHARACTERS

5. *Elevation*—From the numerous experiments conducted since 1935, it is seen that Balsa can grow from sea-level to about 4,000 feet in South India (Latitude 8° to 15° North). Above that elevation due to the cold winds and incidence of frost in winter, the species does not thrive. The optimum elevation appears to be from sea-level to 2,000 feet.

6. *Soil*—Balsa has been grown in a wide variety of soils, from pure sea sand to dark clayey loam. The best growth and development, however, are seen in alluvial loam along the banks of perennial streams and rivers. In red lateritic loam the growth is fair to good, but the

initial growth is rather slow ; in black clayey loam, although the initial height growth is poor, the tree puts on better girth increment than in other types of soils. Sandy and clayey soils appear to be quite unsuitable for Balsa.

7. *Climate and rainfall*—A damp humid climate with temperatures varying between 95°F. and 70°F. and a minimum rainfall of 50 inches distributed over the greater part of the year appear to be the optimum conditions for Balsa. In its early stages, especially in the second year, the young plants cannot stand a hot and prolonged summer and nurse crops giving lateral shade such as *Tephrosia candida* and *Cajanus indicus* have been found to be significantly beneficial.

More than the total quantity, it is the distribution of the rainfall that contributes to the success of a Balsa plantation. In the West Coast of Madras, which gets the benefit of both the south-west and north-east monsoons and the usual pre-monsoon thunder showers in April and May, the growth of balsa appears to be most encouraging. In regions where the rainfall is low and the summer is hot and prolonged, irrigation is significantly beneficial, especially from March to the end of May, and the growth appears to be quite satisfactory. In Bangalore, where the annual rainfall is below 40 inches, a very promising plantation of Balsa has been raised, by irrigating the area during the summer months.

8. *Nursery and planting technique*—The trees flower and bear fruits when they are 3–4 years old. The long capsules mature by the end of March or early in April and are gathered from the trees just when they begin to open. If they are allowed to remain longer, the seeds may be blown off by the wind. The seeds are about twice the size of a mustard, dark brown in colour and weigh 3,000 to an ounce. If stored in lead lined boxes, they retain their viability for about 16–18 months. The germination per cent varies from 75 to 80, but the plant per cent is as low as 25–30, mainly due to the attack of the "damping off" fungus and cutworms. Pretreatment of the seeds before sowing, with cold water for a period of 12 hours and dusting the seed beds with gammaxene or hexadol 10%, have given a plant per cent of more than 50. As the young seedling is very delicate and does not stand transplanting, it is better to raise them in planting baskets or bamboo tubes whichever is cheaper. Well sterilized sandy loam containing not less than 25 to 30% sand is filled into a planting basket or bamboo tube (about 9 to 12 inches long and cut longitudinally) leaving about 2 inches at the top. A pinch of hexadol or gammaxene is mixed with the top layer of the soil and two or three pretreated Balsa seeds are sown. Watering from a fine rose can is done daily till the seedlings are planted out. A light over head shade for the nursery is necessary till the rains set in. A thick low shade is undesirable as it encourages damping off. The germination starts in about seven days and is complete in sixteen to twenty days. As it is not advisable to keep more than one seedling in a tube, they are pricked out and planted in spare baskets kept ready. This operation is done when the seedlings are about 1½ to 2 inches in height, with a teaspoon and is easy provided one is a little careful.

9. *Best time of sowing and planting*—About fifty experiments have been conducted to determine the best time of sowing and it is seen that sowing between second and third week of February is significantly the best. Similar experiments done to find out the best size of transplants, have shown that seedlings of 6–9 inches are the best. Seeds sown by the middle of February will give suitable seedlings by the end of May or early June. Several experiments have been done to determine the most suitable date for transplanting. If at least one or two inches of rain are obtained from the usual pre-monsoon showers in May, it is advisable to start planting by the first week of June ; if not, the planting may be delayed till the middle or even the end of June. Generally speaking, the planting is not done before the ground is sufficiently moist and if the planting is followed by a spell of hot sun, as it often happens in early June, it is desirable to shade the young seedlings by green twigs. Early

(June) planting is significantly beneficial, as the plants can establish themselves quickly and withstand the summer of the following year, which is a critical period.

10. *Preparation of land and planting*—The seedlings are planted in pits one foot cube. The pits are dug early in May and the soil allowed to weather. If planting baskets are used (which is more convenient and beneficial) the basket containing the seedling may be planted as it is and the pit filled up with the soil leaving a shallow basin for water to accumulate. If, on the other hand, split bamboo tubes are used, the seedling with the earth is taken out carefully by removing the two halves of the tube and planted in the pit which is then filled up with earth. The bamboo tubes, if stored properly, could be used for a second time. It is highly necessary to see that while removing the seedlings from the bamboo tubes, the root system is not unduly disturbed and secondly, earth should be pressed tightly round the seedlings after planting, as excessive accumulation of water round the seedlings just after planting is harmful. Till 1950, agricultural crops (*Taungya*) were never grown with Balsa as it was feared that such crops would retard the initial growth of the seedlings. However, experiments done for the last two years have shown that *Taungya* crops such as hill paddy, *Setaria italica*, *Penisetum typhoides* or horse gram do not in any way retard the growth of Balsa. On the other hand, a *Taungya* crop seems to be beneficial in as much as it suppresses the rank weed growth, particularly such gregarious and persistent species as *Ageratum conisoides*, *Cassia tora* and climbers like *Spathalobus roxburghii*, *Butea superba* and *Acacia pennata*.

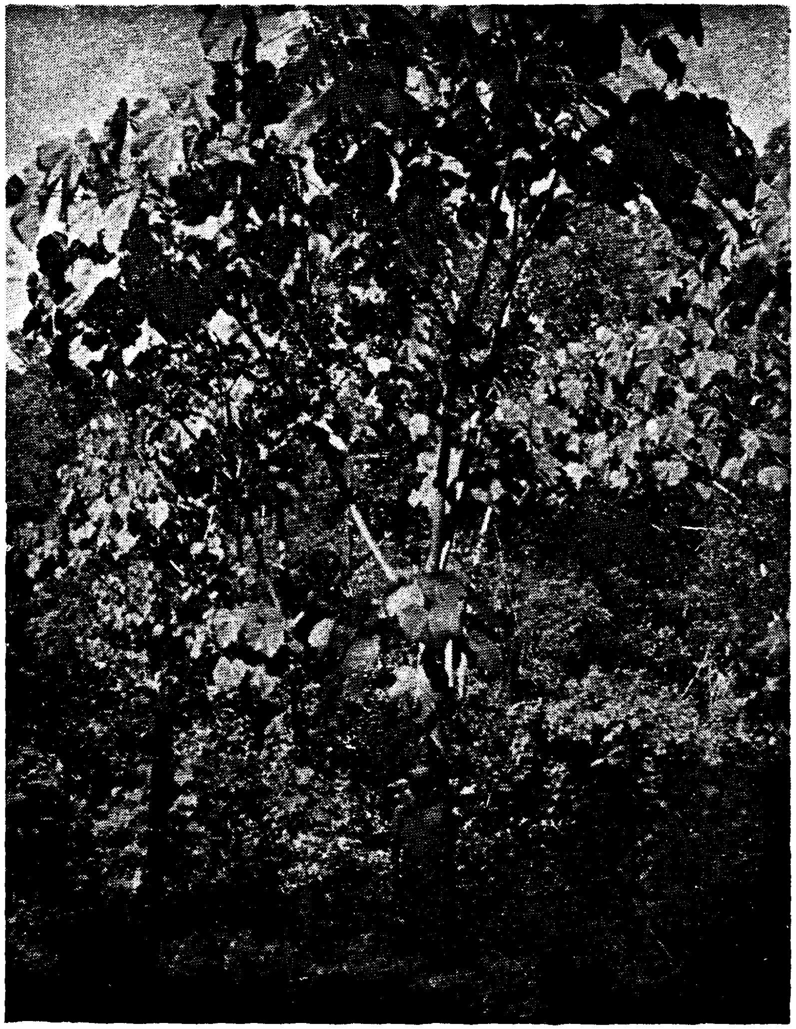
11. *Espacement*—Varying espacements from 3×3 feet to 20×20 feet have been tried in the past, but since 1950, in the large scale plantations an espacement of 17×17 feet has been adopted. Balsa, an extremely fast growing species, has a tendency to branch at the end of the first year's growth and these branches persist giving a short bole of 6–10 feet in length. As pruning was considered harmful, it was thought that close planting would be a remedy. But even close planting has not given the desired results and what is more, being a pronounced light demander, the plants develop into thin whippy stems and are either easily blown over by wind or scorched and killed by the hot sun in the following summer. With a wider espacement, the plants grow vigorously right from the start and are able to withstand both the summer and the strong winds. In poorer localities, where the rainfall and soil are below the optimum, a closer espacement of 15×15 feet or even 12×12 feet may be adopted.

12. *Tending*—Although the rate of growth is rapid, balsa cannot stand weed competition during the first year. Regular weedings, first in September, the second in December and the third by the end of March are necessary in the first year. The critical period for balsa is the summer following the year of planting and heavy casualties may occur due to the scorching of the bark. A soil working and mulching together with nurse crops such as *Tephrosia candida* and *Cajanus indicus*, have been found to be significantly beneficial at this stage. In weeding, particular care should be taken to see that the root system of the plant is in no way injured. From the second year onwards, by which time the plants would have grown to a height of 6–8 feet, the plants become more and more hardy and can withstand both the summer and weed competition. However, in the second year two weedings are necessary : one early in July and the other in December. Thereafter, weeding and other tending operations are not required. In regions of high rainfall – 100 inches and above with a deep fertile soil, the plants develop numerous epicormic branches in the first year between August and September. These branches, if allowed to develop, grow large and the timber may become knotty and useless. As pruning is undesirable, the best and easiest way to get rid of these branches, is to knip the buds off with the fingers when they are tender, usually by the end of August or early in September.

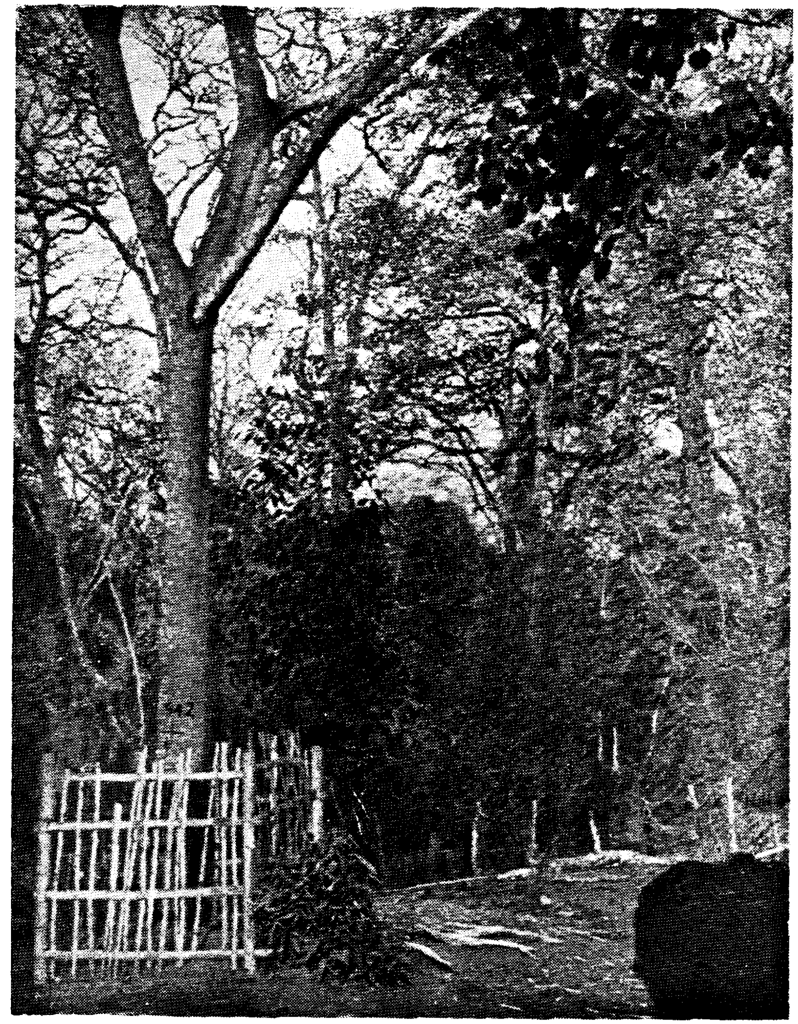
13. *Injuries to which the crop is liable*—The plants are not ordinarily browsed by cattle, but bison sometimes eat the tender leaves. Greater harm is done by the animals

One year old Balsa plants in the Research Garden at Dhoni—Palghat Division.

Two-year old Balsa in Dhoni—Palghat Division.



Four-year old Balsa in Kannoth—Wynad Division.



Eight-year old Balsa in Begur—Wynad Division.

rubbing their horns against the tender stem and damaging the bark resulting in the death of the plant. It is, therefore, advisable not to raise Balsa plantations where wild game is plentiful and protect the plantations with suitable fences where cattle menace is great. In the nursery, the young seedlings are badly attacked by cutworms and wireworms, but this is easily controlled by light dusting with gammaxene or hexadol 10%. During recent years, hexadol has been found to be a very useful and efficient insecticide in Balsa nurseries. A lassiocampid catterpillar does some damage to young plants by defoliating them. The damage, however, is not serious and is completely checked by dusting with hexadol 5 or 10%.

VI. RATE OF GROWTH

14. The rate of growth is rather slow during the first three months, especially in places where the soil is either clayey or lateritic. However, when once the seedlings have established themselves, the growth is extremely rapid. In alluvial loam along the banks of perennial streams and rivers, an average height of 8 feet is reached at the end of the first year. In red loam or clayey loam, the height growth is less rapid but the girth increment is more. The following table gives the rate of growth in three localities :

15. Topslip—South Coimbatore Division – Elevation 2,500 feet ; rainfall 70 inches ; Soil : clayey loam.

Year	Mean height		Mean diameter in inches
	ft.	in.	
1945		8	..
1946	6	4	4·8
1947	17	5	5·4
1948	24	6	6·9
1949	30	1	8·3
1950	36	10	10·9

Dhoni—Malabar District – Elevation 500–1,000 feet ; Soil : red lateritic loam to sandy loam ; rainfall 90–120 inches.

Year	Mean height		Mean diameter in inches
	ft.	in.	
1949	..	6 to 9	..
1950	4	4	..
1951	18	1	..
1952	29	0	..

Kannoth—Malabar District ; Elevation 1,000–1,500 feet ; Soil : Alluvial loam to sandy loam ; rainfall 120–170 inches.

Year	Mean height in feet	Mean diameter in inches
1947	33·7	5·3
1948	44·7	5·9
1949	49·6	6·6
1950	52·0	7·4
1951	57·0	7·9
1952	60·0	8·6

16. It may be mentioned here that while a few seedlings planted at Topslip, South Coimbatore Division, in 1944, reached a girth of 52 inches in 1950, in Begur it took eight years for the plants to attain a girth of 50 inches. Generally speaking the height growth is

better in sandy and alluvial loams but the girth increment is significantly better in thicker soil – dark clayey loams.

VII. UTILIZATION

17. *Properties of the Timber*—Freshly converted timber is easily attacked by fungi resulting in blue stains and what is more, if left in the sun, the logs crack and split badly. It is, therefore, advisable to convert and season the timber immediately after felling, preferably in a Kiln. Tests carried out at the Forest Research Institute, Dehra Dun, with logs supplied by the author, have shown that the timber seasons well without developing any defects and compares favourably with imported Balsa wood.

18. "Balsa wood is remarkable first, as to its lightness, second as to its microscopic structure, third for its heat insulating properties and fourth, for its elasticity". The weight of oven-dry wood varies from 8–14 lbs., per cubic foot and it is the lightest known timber in the world. In spite of its weight it has remarkable strength and elasticity and is, therefore, very valuable in the aircraft industry. The compression strength of balsa wood is about 2,225 lbs. per square inch and the modulus of rupture about one-half that of good spruce. It is extremely elastic : a plank of Balsa wood 10 feet 8 inches between supports $5\frac{1}{2}$ inches wide and $1\frac{3}{4}$ inches thick supported two men who together weighed 387 lbs. ; the maximum deflection at the centre was about 10 inches. Another interesting feature of the wood is that it is almost impossible to split the wood by driving nails through it.

19. *Utilization of the timber*—Commercially the bulk of the wood is used in the manufacture of aeroplane parts, gliders and in the refrigeration industry. In the United States of America and France, balsa wood is largely used in lining refrigerator trucks for transporting perishables. Its more modern uses are in the toy and radio industry. The author got a sample log tested at the W.I M. Co., Match factory and it was found that Balsa wood, due to its peculiar softness could not be peeled and utilized for match boxes or splints. Similarly, the silky cotton like floss could not be spun into yarn, because of its short staple. However, it is an excellent material for stuffing mattresses, pillows and cushions and may be used as a good substitute for silk cotton.

20. *Conclusion*—In a large country like India, air travel is bound to gain in popularity and the air craft industry, though in its infancy, will show a corresponding progress. Besides, the use and significant advantages of air craft of various types and designs in the field of agriculture, have been realized in India during recent years, particularly in the anti-locust campaign in the Punjab, Rajputana and elsewhere. Lastly, the numerous varieties of tropical and sub-tropical fruits produced during certain seasons in our country cannot be transported to long distances due to the lack of refrigerator trucks and the cultivator has to sustain a heavy loss. The production of adequate quantities of Balsa wood will surely solve the above problems to a considerable extent. Along the west coast of India, Orissa, Bengal and other parts, the locality factors are quite suitable for Balsa and what is more the cultivation of Balsa, unlike forestry in general, must be an attractive proposition to the average cultivator, as the tree takes only 8–10 years to mature and the wood fetches a very good price. In this connection, it is encouraging to note that more and more people are taking to the cultivation of Balsa in Malabar and South Kanara Districts of Madras.

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INDIGENOUS CELLULOSIC RAW MATERIALS FOR THE PRODUCTION OF PULP, PAPER AND BOARD

PART XIV.—CHEMICAL PULPS AND WRITING AND PRINTING PAPERS FROM *STERCULIA CAMPANULATA*, WALL.

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SUMMARY

Laboratory experiments on the sulphate digestion of the wood of *Sterculia campanulata*, Wall. (*papita*) are described. The bleached chemical pulps were characterized by high strength properties. The average fibre length of the chemical pulp was 1 ·49 mm. The results of the pilot plant experiments on the production of chemical pulps and writing and printing papers are included. This investigation has indicated that this wood is a suitable raw material for the production of writing and printing papers. A sample of writing paper made entirely from *S. campanulata* pulp and another of printing paper made from a mixture of 68% *S. campanulata* pulp and 32% bamboo pulp are appended.

INTRODUCTION

Sterculia campanulata, Wall. (*papita*) is a large, tall tree, 100–130 feet in height and 8–10 feet in girth. The wood is cream in colour but is quickly discoloured with bluish-black fungus staining if not dried immediately after felling and conversion ; once it is dried, it remains in a clean condition indefinitely[1]. The wood is light in weight, 1 cu. ft. (air-dry) weighing 21–25 lb. This species is very common in the deciduous forests of the Andamans. It is also reported to be available in the Nicobar Islands. It is found in Lower Burma, Mergui and Tavoy. There is a great demand for this wood in the match industry in Calcutta for the manufacture of match splints and boxes.

The Government of India in its general scheme of the utilization of the forest resources of the Andaman Islands suggested that *S. campanulata* and *Sterculia alata* (*letkok*) should be tested for their suitability for paper pulp. The work carried out so far on the production of newsprint grade mechanical pulp from *papita* has already been published[2]. The results of the laboratory and pilot plant experiments on the chemical pulping of this wood and the production of writing and printing papers from these pulps are recorded here.

THE RAW MATERIAL

Four billets, 8–8 ·5 feet in length and 14–15 inches in diameter, were supplied by the Chief Conservator of Forests, Andamans, for the laboratory experiments. The age of the trees from which these billets were prepared was 30–35 years. For the pilot plant experiments 15 logs weighing about 5 tons were received from the Andamans. The moisture content of the wood as received was 43%. The wood was chipped and screened. The screened chips were used for the experiments.

PROXIMATE ANALYSIS

The chips (250 g.) from billets received for the laboratory experiments were reduced to dust and the portion passing through 60-mesh and retained on 80-mesh was used for the proximate analysis. The results are given in Table I.

TABLE I

Proximate analysis of Sterculia campanulata

		% on the oven-dry basis except moisture
1.	Moisture	6·62
2.	Ash	1·01
3.	Cold water solubility	1·47
4.	Hot water solubility	2·59
5.	1% NaOH solubility	17·94
6.	10% KOH solubility	25·87
7.	Ether solubility	0·15
8.	Alcohol-benzene solubility	1·48
9.	Pentosans	15·51
10.	Lignin	23·83
11.	Cellulose (Cross and Bevan)	59·50

The cellulose content of this wood is high enough to warrant its utilization for the production of paper pulp.

FIBRE DIMENSIONS

The measurements of the length and diameter of fibres of the chemical pulp from this wood were carried out by the usual procedures followed in this laboratory. The average fibre length was found to be 1·49 mm., the minimum and maximum values being 0·91 and 1·96 mm., respectively. The fibre diameter of the pulp varied from 0·0260 to 0·0450 mm., with an average of 0·0390 mm. The ratio of average fibre length to diameter was 38 : 1. As is usual with hardwood pulps, the value of this ratio is small compared to pulps from coniferous woods, bamboo and grasses.

PRODUCTION OF PULP

Several digestions were carried out on a laboratory scale by the sulphate process using caustic soda and sodium sulphide in the ratio of 2 : 1. The quantity of chemicals was varied from 20 to 24% on the oven-dry weight of the chips and the temperature from 142° to 162°C. Most of the digestions were carried out for 5 hours. Digestions with a higher quantity of chemicals and at a higher temperature were also carried out for 3 and 4 hours.

For the laboratory digestions, 200 g. of the chips were used. After completing the digestion, the pulp was washed on a 60-mesh sieve and bleached with a solution of bleaching powder in two stages. After the first stage of bleaching, the partially bleached pulp was treated for 1 hour in 5% consistency with 2% caustic soda (on the weight of the oven-dry pulp) at 70°C. After finally bleaching the pulp, it was beaten in the Lampen Mill to the

required freeness and standard pulp sheets were made on sheet machine. After drying in the way recommended in the Second Report of the Pulp Evaluation Committee to the Technical Section of the Paper Makers' Association of Great Britain and Ireland (now known as the British Paper and Board Makers' Association), the pulp sheets were used for determining the strength properties.

The conditions of various digestions, the pulp yields, the consumption of bleaching powder, and strength properties of the standard pulp sheets are given in Table II. The digestion period recorded in Table II is the total of the time required by the cooking liquor to rise to the cooking temperature from 100°C., and the time of cooking at the maximum temperature.

PILOT PLANT TRIALS

Two pilot plant experiments were carried out in order to confirm the suitability of this wood for the production of bleached chemical pulps and of white writing and printing papers. About 650 lb. of chips were used in each digestion. A vertical mild steel digester of 100 cu. ft. capacity and of indirect heating, forced circulation type was used. Both the digestions were carried out by the sulphate process using caustic soda and sodium sulphide in the ratio of 2 : 1. After the digestion was over, the pulp was taken into the potcher and washed. It was bleached in the same machine in two stages with the intermediate alkali wash in the first experiment and without this treatment in the second experiment. As usual, the first stage of the bleaching was carried out at 35°C. and the second stage at room temperature.

In the first experiment, the chips were cooked with 24% of total chemicals in a concentration of 55 g./litre at 153°C. The cooking liquor was brought to 153°C. from 100°C. in 3/4 hour and the cooking was carried out at 153°C. for 5¼ hours. The consumption of chemicals was 20·0%. The yields of the unbleached and bleached pulps were 49·3% and 47·2% respectively and the bleach consumption was 7·0% of the standard bleaching powder containing 35% available chlorine. All these percentages are expressed on the weight of the oven-dry raw material. In this experiment the intermediate alkali treatment was given during the bleaching process. Well-cooked pulp was obtained. The bleached pulp was white and bright.

The second pilot plant digestion was carried out with 24% of the total chemicals in a concentration of 50 g./litre at 162°C. The temperature of the cooking liquor was raised from 100°C. to 162°C. in 1/2 hour and the digestion was carried out at 162°C. for 4½ hours. The consumption of chemicals was 22·8%. The yields of the unbleached and bleached pulps were 48·9% and 46·3% respectively. The bleach consumption was 8·5% of the standard bleaching powder. The intermediate alkali treatment was not given during the bleaching process. Well-cooked pulp was obtained. The bleached pulp was white and bright.

The pulps from these experiments were beaten separately. Requisite quantities of rosin size, alum, china clay and titanium oxide were added and the stock was used for making papers. Writing paper was made from the stock containing pulp from the first experiment; a sample of this paper is appended. Bamboo beaten pulp was added to the stock containing pulp from the second experiment. This stock containing *papita* and bamboo pulps in the ratio of 68 : 32 was used for making printing paper. A sample of this printing paper is also appended in this bulletin. The strength properties of these two papers are given in Table III.

TABLE III

Strength properties of papers from S. campanulata (pilot palnt trials)

The papers were conditioned at 65% R.H. and 80°F. before test.

Property	Writing paper from 100% *S. campanulata* pulp	Printing paper from a mixture of 68% *S. campanulata* pulp and 32% bamboo bleached pulp
1. Freeness, c.c. (C.S.F.)	150	155
2. Ream weight in lb., 17½" × 22½" — 500	19·1	16·7
3. Basis weight*, g./sq. metre ..	68·1	59·8
4. Thickness, mils (1/1000 inch) ..	3·50	3·90
5. Tensile strength (Schopper), kg. per cm. width		
(*a*) Machine direction ..	3·23	2·85
(*b*) Cross direction	1·54	1·28
6. Breaking length*, metres		
(*a*) Machine direction ..	4740	4770
(*b*) Cross direction	2260	2140
7. Stretch%		
(*a*) Machine direction ..	1·3	2·0
(*b*) Cross direction	2·6	4·2
8. Tearing resistance (Marx-Elmendorf), g.		
(*a*) Machine direction ..	38·7	46·5
(*b*) Cross direction	43·2	52·0
9. Tear factor*		
(*a*) Machine direction ..	56·8	77·8
(*b*) Cross direction	63·5	87·0
10. Bursting strength (Ashcroft), lb./sq. inch	21·9	20·6
11. Burst factor*	22·6	24·2
12. Folding endurance, double folds		
(*a*) Machine direction ..	22	55
(*b*) Cross direction	12	18

* For calculating this, oven-dry weight of the paper was used.

DISCUSSION

The data recorded in Table II show that bleached chemical pulps with satisfactory strength properties can be prepared from the wood of *S. campanulata* by the sulphate process. Generally there is a fall in the yields of pulps as the temperature of the digestion is increased from 153° to 162°C. Under the conditions studied the optimum conditions for the digestion of the wood are those recorded in Serial Nos. 5 and 7, Table II. It is best to cook the chips at 153°C. for 5 hours with 22 or 24% of chemicals on the weight of the oven-dry raw material. These conditions are mild for wood. The yield of 48% of bleached pulp is satisfactory. So also is the bleach consumption. When the digestion is carried out at 162°C. with 24% chemicals, the period of cooking should be reduced in order to get pulp in good yield and with high strength properties. The average fibre length of the pulp is 1·49 mm., nearly the same as that of esparto grass used in the United Kingdom for the manufacture of paper.

The results of the pilot plant experiments indicate that writing and printing papers in good yields and with satisfactory strength properties can be prepared from the wood of *S. campanulata*. When 24% of chemicals are used, the temperature of 162°C. for cooking does not seem to be preferable to 153°C. when the digestion is carried out for 5–6 hours. The bleach consumption is more and the yield of the pulp is less at the higher temperature of 162°C. Blending of bamboo pulp with *S. campanulata* pulp helps in improving the strength properties, especially, tear, double folds and stretch. The formation and brightness of the papers are satisfactory.

CONCLUSIONS

1. Easy bleaching chemical pulps in good yields and with satisfactory strength properties can be prepared by the sulphate process from the wood of *Sterculia campanulata*.

2. The digestion conditions for pulping this wood are milder than those generally used for other woods.

3. The average fibre length of the pulp from this wood is 1·49 mm., which is nearly the same as that of esparto grass.

4. Admixture of bamboo bleached pulp with *S. campanulata* bleached pulp improves the strength properties of papers.

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TABLE II.—*Sulphate digestions of Sterculia campanulata*

DIGESTION CONDITIONS AND PULP YIELDS

1	2	3	4	5	6	7	8	9
Serial No.	Total chemicals* (NaOH : Na_2S=2 : 1)	Concentration of chemicals	Digestion temperature	Digestion period	Consumption of chemicals*	Unbleached pulp yield*	Bleach consumption as standard bleaching powder*	Bleached pulp yield*
	%	g./litre	°C.	hours	%	%	%	%
1	20	50	142	5	18·6	54·2	7·0	50·0
2	20	50	153	5	18·6	53·0	6·4	50·0
3	20	50	162	5	19·7	48·8	5·3	47·0
4	22	55	142	5	20·0	52·9	5·6	48·5
5	22	55	153	5	21·0	50·9	5·4	48·0
6	24	60	142	5	22·0	51·8	5·0	47·3
7	24	60	153	5	22·0	51·1	4·7	48·0
8	24	60	162	5½	22·1	44·4	4·8	41·3
9	24	60	162	4	21·3	50·0	5·3	46·3
10	24	60	162	3	21·8	49·4	6·6	46·2

* The % is expressed on the basis of the raw material (oven-dry).

and strength properties of standard pulp sheets

STRENGTH PROPERTIES OF STANDARD PULP SHEETS CONDITIONED AT 65% R.H. AND 70°F.

10	11	12	13	14	15	16	17
Freeness of pulp	Basis weight	Breaking length	Stretch	Tear factor (Marx-Elmendorf)	Burst factor (Ashcroft)	Folding resistance	REMARKS
c.c. (C.S.F.)	g./sq. metre	metres	%			double folds	
300	58·6	8650	4·5	122·0	61·0	3950	Well-cooked pulps were obtained in Serial Nos. 1–10.
250	58·2	7800	4·8	122·0	53·0	2950	
300	57·9	9040	3·8	94·0	43·0	1830	
295	57·7	9860	4·0	100·0	52·0	2360	
270	62·4	9680	4·0	102·0	50·0	2270	
325	56·4	9460	4·0	96·0	50·0	2140	
270	61·5	8530	4·3	104·0	40·0	1360	
270	61·5	8540	4·3	104·0	40·0	1360	
305	62·3	8990	3·8	108·0	42·0	1890	
295	57·7	9860	4·0	100·0	52·0	2360	

VEGETATIVE PROPAGATION AND FOREST TREE IMPROVEMENT

BY H. S. RAO, D.SC., F.B.S.

SUMMARY

In tree improvement work we seek to recognize desirable individuals in nature, multiply them as such vegetatively, while at the same time attempt to combine useful traits of different individuals into a synthetic hybrid. The resulting improved hybrid may further have to be clonally multiplied to preserve its complex genetic make-up. Even when a good genotype has been found which produces seed of dependable heredity, it may have to be vegetatively multiplied and grown in compact seed orchards. Scions of such individuals will have to be budded or grafted on wild stock for this purpose. Thus at all stages vegetative propagation is an invaluable aid.

The speed and success of tree improvement for large-scale afforestation depends on vegetative multiplication in a large measure. Tree species vary in their ability to regenerate vegetatively, namely, through cuttings, layers, budding or grafting. On a scrutiny of the Indian forest species it was found that no less than 74 species reproduce by cuttings, 11 by layers, 9 by grafting or budding, and 104 by root-suckers, which shows the scope there is for selection and multiplication of good phenotypes or genotypes.

Coppicing ability is also an indication of the faculty for vegetative reproduction. There are no less than 161 species which coppice more or less vigorously. With the aid of hormones many of them may be induced to root. Hormones might also be employed to increase greatly the percentage success of those which normally strike root.

Thus, intensive vegetative propagation promises wonderful possibilities of forest tree improvement.

Vegetative propagation is a valuable aid to tree breeding. In tree improvement work we seek to recognize desirable individuals in nature, multiply them as such, while at the same time attempt to combine useful traits of different individuals into a synthetic hybrid. Whether the desirable individual has been found in nature, or has been produced by hybridization, the next step is to multiply it clonally. The clone is of special importance to the forest geneticist for early improvement of forest trees. Clonal multiplication is imperative where the progeny of a desirable kind of tree do not breed true to the mother-tree. It is true that many species are not amenable to vegetative propagation. However, it is fortunate that quite a number of economically important tree species can be vegetatively propagated, and many more can probably be multiplied clonally with the aid of modern techniques such as hormone treatments (Snow, 1942 ; Schreiner, 1939 ; Doran, 1941 ; Farrar and Grace, 1942).

In the case of species where artificial regeneration is regularly resorted to in forestry, the use of clonal material is perhaps quite feasible. There are of course, involved the time and labour required to prepare the rooted clones. The extra cost, however, may be justifiable with important species.

A modern method of producing pedigree seed for afforestation purpose is to produce it in what has come to be known as tree seed orchards (Rao, 1951). Once a pure-breeding individual, or genotype is recognized or bred according to genetic procedures, it becomes necessary to produce bulk quantities of its seed in accordance with the needs. It will then become necessary to grow a number of clones of such a genotype individual in compact orchards in isolated spots for the production of seed. If the species allows of simple propagation by

cuttings, it is an easy matter. Budding and grafting of scions of the genotype on 'wild' rootstock may have to be done in other cases. In either case there is implicit a certain degree of facility in vegetative reproduction of the species in question.

It is not intended here to go into the techniques of vegetative propagation, namely, of cuttings, layerings, grafting and budding or of the accessory aid of hormones in rooting. These procedures are adequately described in horticultural literature (Adriance and Brison, 1939; Hottes, 1945; Avery and Johnson, 1947).

As to the ease with which vegetative propagation occurs, plant species are of variable ability determined by internal physiological and genetical factors. Certain genera and families have remarkable powers of vegetative reproduction as for example, Rosaceæ. Others can be propagated with special care or hormone treatment ; while many other species are notoriously refractory.

The ability to produce root-suckers is a good indication of regenerative ability. The ability to produce coppice shoots is also a fair indication of its power for vegetative propagation. In a programme of tree improvement it is necessary to know the degree of facility with which a selected individual, – phenotype or genotype (i.e., genetically heterogeneous or pure) – can be clonally multiplied to the desired numbers without affecting its heredity. Almost all our fruit plants such as apple, mango, citrus, grapes, etc., have thus been increased from single individuals which arose either as chance mutations or as a result of hybridization. The rapid improvement of horticultural plants owes primarily to the possibility of multiplying excellent selected individuals by cuttings, layering, grafting or budding. Reliable varieties are thus established in horticulture. It is a logical step to extend the method to silviculture.

With a view to find out the species of Indian trees which are amenable to vegetative propagation for the aim of improvement of trees, I looked up R. S. Troup's Silviculture of Indian Trees, and was gratified to find a large number of species of promise. Foresters have no doubt recognized good mother-trees or elites of the different species in their respective regions. Painstaking foresters have collected seed from only such individuals (Trevor, 1937). But these trees have not always been in easily accessible places. Therefore, the next urgent step would be to vegetatively propagate them and grow them in compact blocks for subsequent study, multiplication by clone and seed, or for further genetic improvement by hybridization and other methods. It would, therefore, be desirable that Divisional or Range Forest Officers establish in their respective regions compact clonal plantations of valuable germ plasm consisting of about 30 clones (Johnsson, 1949). A beginning should be made with the more important species in each region.

In the following lists prepared from information available in Troup's work, the species are classified according to the degrees of propagative ability by vegetative means. Obviously, successful multiplication through cuttings indicates first order regenerative ability ; layers, budding and grafting coming next. The production of root-suckers is often a manifestation of this ability and is the natural method of its expression, because cuttings, layers, budding or grafting result only through man's intervention. The coppicing power possessed by many species is here taken as indicative of a natural propensity to burst forth into vegetative activity when a calamity like man's axe or fires threaten to curtail their life. All these above categories of plants will probably respond to appropriate hormone treatments.

On an examination of the species listed here certain trends within families became apparent, although the remarks by no means can be taken to mean that all the genera and species of each family behave in the same manner.

The following families seem to comprise species having good vegetative propagating ability: *Annonaceæ, Tamaricaceæ, Malvaceæ, Sterculiaceæ, Tiliaceæ, Simarubaceæ, Meliaceæ,*

Celastraceæ, *Rhamnaceæ*, *Sapindaceæ*, *Anacardiaceæ*, *Moringaceæ*, certain *Leguminosæ*, *Rosaceæ*, *Hamamelidaceæ*, *Rhizophoraceæ*, *Myrtaceæ*, *Lythraceæ*, *Samidaceæ*, *Rubiaceæ*, *Ebenaceæ*, *Oleaceæ*, *Salvadoraceæ*, *Apocynaceæ*, *Loganiaceæ*, *Boraginaceæ*, *Bignoniaceæ*, *Verbenaceæ*, *Lauraceæ*, *Euphorbiaceæ*, *Ulmaceæ*, *Moraceæ*, *Platanaceæ*, *Juglandaceæ*, *Betulaceæ*, *Fagaceæ* and *Salicaceæ*. In the monocotyledons certain palms can be multiplied by offsets or suckers, and the bamboos by rhizones. The majority of the coniferæ do not possess vegetative propagating ability. Some, however, are raised from cuttings. A few appear to respond to special treatments. A number of conifers have been vegetatively propagated in the temperates although in India very few have been so treated.

The following table summarizes the vegetatively propagating ability possessed by Indian forest species.

(* Numbers in brackets with asterisks denote those possessing especially remarkable ability).

	Cuttings	Layers	Grafting or budding	Root-suckers	Coppices
No. of genera ..	49 (27*)	10 (3*)	9 (9*)	75 (45*)	110 (68*)
No. of species ..	74 (39*)	11 (3*)	9 (9*)	104 (56*)	161 (95*)

It is found that no less than 156 species are amenable to ready clonal propagation of one kind or another. Of the species that coppice, which here are assumed to have potentialities for clonal multiplication, 161 are recorded of which 95 are especially vigorous. Over 60 (64) of the 161 also reproduce by one or the other vegetative means, leaving about a hundred which *coppice only*. To these numbers would probably be added a number of other species which foresters have since observed or might discover in future as regenerating vegetatively at some locality or other in certain seasons, implying special environmental or physiological conditions. If we were to extend the list further by those species which yield to special treatments like hormones, etc., we have a situation where intensive selection among species promises wonderful possibilities of forest species improvement. This is of course an immense task. In the beginning, no doubt, only the more important economic species would be taken up for improvement programmes.

ACKNOWLEDGMENTS

My thanks are due to Mr. V. P. Mathur, Dean, Indian Forest College, for going through the manuscript and giving helpful suggestions.

(Asterisks denote species that respond particularly well)

SPECIES PROPAGATED BY CUTTING OR LAYERS

CUTTINGS

*Adenanthera pavonia**
*Albizzia procera**
Artocarpus incisa (root cuttings)
*Boswellia serrata**
*Buxus wallichiana**
Castilloa elastica (from main shoots)
*Ailanthus excelsa**
*Alnus nitida**
Broussonetia papyrifera
Buxus papillosa
*Carallia brachiata** (= *C. lucida*)
Cedrus deodara (in S. Africa)
*Ceiba pentandra** (= *Eriodendron anfractuosum*)

(contd.)

SPECIES PROPAGATED BY CUTTING OR LAYERS—(*concld.*)

CUTTINGS

Cinnamomum camphora
(root-cutting better than stem)
Cupressus lawsoniana
*Dalbergia sissoo** (stem and root cutting)
*Ficus bengalensis**
F. elastica
F. hispida
F. pumila
F. retusa
*Gmelina arborea**
(large cuttings during rains)
Hevea braziliensis
Juniperus recurva
Manihot glaziovii
*Millingtonia hortensis**
*Morus alba**
*Olea cuspidata**
*Platanus orientalis**
*Populus alba**
P. euphratica
*Prunus cerasoides** (= *P. puddum*)
Punica granatum
*Salix babylonica**
S. cœrulea
*S. elegans**
Salmalia malabarica (= *Bombax malabaricum*
(cuttings strike but difficult to establish)
*Sapium insigne**
(cuttings from ends of shoots)
*Spondias pinnata** (= *Spondias mangifera*)
*Tamarix troupii**
*Tecomella undulata** (= *Tecoma u.*)
Trewia nudiflora (well in rains)

Cryptomeria japonica (in S. Japan)
Dalbergia latifolia (stem or root cuttings)
Delonix regia (= *Poinciana regia*)
Ficus carica
*F. gibbosa**
F. palmata
F. religiosa
*Garuga pinnata**
*Grewia oppositifolia**
Jatropha curcas
Lannea grandis (= *Odina wodier*)
Melia azedarach
*Moringa oleifera** (= *M. pterygosperma*)
*Morus serrata**
Ougenia dalbergioides (root cuttings)
*Pongamia pinnata** (= *P. glabra*)
*Populus ciliata**
*P. nigra**
*Pterocarpus indicus** *Pt. santalinus*
Robinia pseudacacia (root cuttings)
*Salix caprœa**
*S. daphnoides** (in Lahoul)
*S. tetrasperma**
Sapindus detergens
Sapium sebiferum
*Tamarix articulata**
Taxus baccata
*Thespesia populnea**
*Vitex negundo**

LAYERS

Amherstia nobilis
Casuarina equisetifolia
Ficus elastica
*Grewia hainesiana**
Populus ciliata (natural layers)
Swietenia mahagoni (in Calcutta)

the bamboos
Cinnamomum camphora
*Ficus pumila**
*Platanus orientalis**
Salvadora oleoides

SPECIES PROPAGATED BY GRAFTING AND BUDDING

GRAFTING

Cedrus deodara
Juglans regia
Manilkara hexandra (as stock for grafting)
Acras zapota
Zizyphus mauritiana (= *Z. jujuba*) (varieties on wild stock of same)

*Hevea braziliensis**
*Mangifera indica**
Robinia pseudacacia

(contd.)

SPECIES PROPAGATED BY GRAFTING AND BUDDING—(*concld.*)

BUDDING

*Hevea braziliensis**
Juglans regia

SPECIES PROPAGATED BY ROOT SUCKERS

Acacia arabica (Kistna Dt.)
Acacia catechu
A. dealbata
*A. decurrens**
A. leucophlœa
A. melanoxylon
*A. planifrons**
Acer cæsium
*Aegle marmelos**
*Ailanthus glandulosa**
*Albizzia amara**
*Albizzia julibrissin** (= *A. mollis*)
*A. lucida**
Albizzia lebbeck
A. procera (in Bombay)
Anogeissus latifolia
*Anogeissus pendula**
Artocarpus hirsuta
*Azadirachta indica** (in dry areas)
*A. incisa**
the bamboos (by 'offsets')
*Berria mollis** (= *B. ammonilla*)
*Boswellia serrata**
Bridelia retusa
*Broussonetia papyrifera**
*Capparis aphylla**
*Carallia brachiata** (= *C. lucida*)
*Carissa spinarum**
*Cassia fistula**
Casuarina equisetifolia (in coastal places)
*Cedrela serrata** (to considerable distances around parent)
*Cinnamomum camphora**
Cleistanthus collinus
*Croton oblongifolius**
*Dalbergia latifolia**
*Dalbergia sissoo**
*Dichrostachys cinerea**
*Diospyros burmanica**
Diospyros chloroxylon
*D. melanoxylon**
Dipterocarpus tuberculatus (occasionally in Siam)
Ehretia lævis
*Elæodendron glaucum**
*Engelhardtia spicata**
*Ficus hispida**
Gmelina arborea (rarely in Changa Manga)
Hardwickia binata
*Holarrhena antidysenterica**
Lannea grandis (= *Odina wodier*)
Mallotus philippinensis
*Melia azedarach**
Miliusa velutina
*Millingtonia hortensis**
Morus serrata
Nannorhops richieana (by 'offsets')
Nipa fruticans (rhizomes)
*Nyctanthes arbor-tristis**
Olea cuspidata
*Oroxylum indicum**
Ougenia dalbergioides
Pentacme suavis (occasionally in Siam)
Phœnix dactylifera (by 'offsets')
*Phœnix humilis**
Polyalthia cerasoides
Populus alba
Pongamia pinnata (= *P. glabra*)
*P. euphratica**
*Populus ciliata**
*P. nigra** (when tree is cut)
Prosopis juliflora
*Prosopis spicigera**
*Prunus padus**
*Prunus cerasoides** (= *P. puddum*)
*Pterospermum acerifolium**
*Pyrus pashia**
Randia spinosa (*R. dumetorum*)
*Randia uliginosa**
*Rhus parviflora**
*Robinia pseudacacia**
Salmalia malabarica (= *Bombax malabaricum*)
*Salvadora oleoides**

(contd.)

SPECIES PROPAGATED BY ROOT SUCKERS—(*concld.*)

*Santalum album**	*Sapium sebiferum**
Schleichera oleosa (*Schl. trijuga*)	*Schrebera swietenioides*
*Stereospermum chelonioides**	*Stereospermum neuranthum*
St. suaveolens	*St. xylocarpum*
Strychnos nuxvomica	*Strychnos potatorum*
Tectona grandis (rare)	*Terminalia arjuna*
Terminalia tomentosa (occasionally)	*Trewia nudiflora*
Vitex altissima	*Vitex negundo*
Wrightia tinctoria	*Xylia xylocarpa**
Zizyphus mauritiana (= *Z. jujuba*)	*Zizyphus nummularia**
*Z. vulgaris** (spreads over bare hills)	

SPECIES THAT COPPICE

Acacia arabica (in Guntur)	*Acacia catechu**
*A. dealbata**	*A. decurrens**
*A. leucophlœa**	*A. melanoxylon*
*A. modesta**	*A. planifrons*
*Acer oblongum**	*Adina cordifolia*
*Aegiceras majus**	*Aegle marmelos*
*Albizzia amara**	*Albizzia odoratissima**
Alstonia scholaris	*Anogeissus latifolia*
Anogeissus pendula	*Anthocephalus candamba**
Artocarpus chaplasha	*Artocarpus hirsuta*
*A. integra** (= *A. integrifolia*)	*Avicennia officinalis*
*Azadirachta indica**	*Bauhinia racemosa*
Bauhinia retusa	*B. variegata*
Berria mollis (= *B. ammonilla*)	*Bischoffia javanica**
*Boswellia serrata**	*Bridelia retusa**
*Broussonetia papyrifera**	*Buchanania lanzan* (= *B. latifolia*)
Bucklandia populnea (when young)	*Butea monosperma* (= *B. frondosa*)
*Capparis aphylla**	*Carallia brachiata* (= *C. lucida*)
*Careya arborea**	*Carissa spinarum**
Casearia tomentosa	*Cassia auriculata**
*Cassia fistula**	*Castanea sativa**
*Castanopsis hystrix**	*Castanopsis indica**
*C. tribuloides**	*Casuarina equisetifolia* (poor)
*Celtis australis**	*Ceriops roxburghiana*
*Chickrassia tabularis**	*Chloroxylon swietenia* (in S. Vellore, Madras)
*Cinnamomum cecicodaphne**	*Cinnamomum zeylancium*
*Cleistanthus collinus**	
Cleistocalyx operculata (= *Eugenia operculata*)	
Cordia vestita	*Cordia dichotoma** (= *C. myxa*)
*Croton oblongifolius**	*Dalbergia sissoo**
Dillenia indica	*Dillenia pentagyna*
Diospyros melanoxylon	*Dipterocarpus obtusifolius*
*Dipterocarpus tuberculatus**	*Ehretia lævis**
*Emblica officinalis** (= *Phyllanthus emblica*)	*Engelhardtia spicata*
*Erythrina suberosa**	*Eucalyptus globulus**
*Eucalyptus tereticornis**	

(contd.)

SPECIES THAT COPPICE—(*concld.*)

Ficus hispida
Fraxinus excelsior
*Garuga pinnata**
*Grewia elastica**
*G. tiliæfolia**
Heritiera fomes
Holoptelea integrifolia
Hopea wightiana var. *glabra**
*Lagerstrœmia speciosa** (= *L. flos-reginæ*)
*L. parviflora**
Litsœa sebifera
Macaranga denticulata
Madhuca latifolia (= *Bassia latifolia*)
Mesua ferrea
Miliusa velutina
Morus indica
*Nyctanthes arbor-tristis**
Ougenia dalbergioides
*Pentacme suavis**
Pistacia mutica (in Baluchistan)
*Pœciloneuron indicum**
*Populus euphratica**
*Prunus racemosa** (= *P. padus*)
Pterocarpus marsupium
Quercus floribunda (= *Q. dilatata*)
*Quercus incana**
*Q. lamellosa**
Q. lanuginosa
*Q. spicata**
*Rhus parviflora**
*Salix tetrasperma**
*S. persica**
*Schima wallichii**
*Semecarpus anacardium**
*Shorea robusta**
Stephegyne parvifolia
*Sterculia villosa**
Stereospermum sauveolens
*Syzygium cumini** (= *Eugenia jambolana*)
*Tecomella undulata** (= *Tecoma u.*)
*Tectona hamiltoniana**
*Terminalia bellerica**
*T. paniculata**
*Trewia nudiflora**
*Wrightia tomentosa**
Zizyphus mauritiana (= *Z. jujuba*)

Flacourtia ramontchi
Fraxinus xanthoxyloides
*Gmelina arborea**
*Grewia microcos**
*Helicters isora**
*Holarrhena antidysenterica**
*Homalium tomentosum**
Kydia calycina
Lagerstrœmia lanceolata
Lannea grandis (= *Odina wodier*)
*Leucœna glauca**
*Machilus bombycina**
*Mallotus philippinensis**
Michelia champaca
*Moringa oleifera** (= *M. pterygosperma*)
*Morus serrata**
Olea cuspidata
*Parrotia jacquemontiana**
*Pieris ovalifolia**
*Pithecolobium dulce**
Populus ciliata (when young)
*Prosopis spicigera**
*Pterocarpus dalbergioides**
*Pterospermum acerifolium**
*Quercus glauca**
*Quercus ilex**

*Q. semecarpifolia**
*Rhododendron arboreum** (slow growth)
Saccopetalum tomentosum
*Salvadora oleoides**
Santalum album
*Schleichera oleosa** (= *Schl. trijuga*)
*Shorea obtusa**
Soymida febrifuga
*Sterculia alata**
*Stereospermum chelonioides**
Tamarix troupii

*Tectona grandis**
*Terminalia arjuna**
T. chebula
*T. tomentosa**
*Woodfordia floribunda**
*Xylia xylocarpa**
Zizyphus xylopyrus

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SOUTH RAIPUR SAL FOREST AND ITS ECOLOGICAL STUDY, WITH SPECIAL REFERENCE TO ITS MANAGEMENT

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The first systematic working plan for the South Raipur Sal forest was prepared in 1924 by Shri C. M. Harlow. The description of the forest given by him is interesting. He wrote – "....in the absence of any detailed knowledge of the geology and soils of the neighbourhood, no attempt has been possible to work out the ecology of Sal. It may, however, be definitely stated that Sal avoids swampy areas, dry rocky localities, alluvial deposits and clayey soils....The best Sal forests occur on flat regular plains where the soil is a deep loamy sand or sandy loam and where the ground is little broken up by *nalas*....On shallow soils or broken ground where the soil has been washed away the Sal forest is invariably poor and stunted....The commonest associates of Sal are – In the overwood *Pterocarpus marsupium*, *Terminalia tomentosa*, *Bassia latifolia*, *Anogeissus latifolia* in general and in some localities *Ougeinia dalbergioides*, *Boswellia serrata*. In the middle-storey *Buchanania latifolia*, *Diospyros melanoxylon*, *Terminalia chebula*, *Phyllanthus emblica*, *Cleistanthus collinus*, *Grewia tiliæfolia*, *Lagerstrœmia parviflora* in general, and in some localities *Eugenia jambolana*. Among the commoner shrubs are *Woodfordia floribunda*, *Wendlandia exserta*, *Indigofera arborea*, *Nyctanthes arbor-tristis*, *Phœnix acaulis*, *Dioscorea dœmona*, *Clerodendron serratum*, *Dillenia aurea*, *Grewia hirsuta* and *Embelia robusta*....No tree of other species can be said to be really conspicuous in the Sal forest ; *Pterocarpus marsupium* is perhaps the most conspicuous, largely on account of its light coloured bark. Individuals are nearly always malformed and are rarely found competing successfully with the Sal....*Terminalia tomentosa* and *Bassia latifolia* in the better forests and *Anogeissus latifolia* in the poorer forests are to be occasionally found with the Sal in the upper storey. The other trees found in Sal forest are usually in the middle or lower storey. Compared with the majority of the Sal forests of Madhya Pradesh the regeneration may be described as very good. It is, however, not universally so"....This first description of the South Raipur Sal Forest, no doubt, gives a fair idea as regards crop composition and also gives its broad classification into 'better Sal forest' and 'poor Sal forest' for management purposes. The ecological sub-types of Sal forests, however, are not described.

In 1933, however, these Sal forests were visited by Shri H. G. Champion and he distinguished the following sub-types which are detailed in his publications, viz., "Regeneration and Management of Sal (1933)", and "A preliminary survey of the Forests types of India and Burma (1936)".

(1) *A3 – Dry Peninsular Sal*—It occurs on crystalline rocks with dry shallow soil. The quality class is M.P. (Madhya Pradesh) III and IV (below 70 feet). The selected characteristic associated species in top canopy are *Anogeissus latifolia* and *Boswellia serrata*, and in lower canopies *Gardenia* spp., and *Wendlandia tinctoria*. . The main grasses are *Ischœmum angustifolium* and *Dendrocalamus strictus*. The characteristic grass, which is the outstanding feature of the sub-type, is *sabai* grass. The regeneration, here, is fair but very slow and best with shade.

(2) *B2 – Moist Peninsular Sal*—It occurs on crystalline rocks with yellow soils. The quality class is M.P. I/II (over 90 feet 90—70 feet). The selected characteristic associated species in the top canopy is *Pterocarpus marsupium*, and in lower canopies *Indigofera pulchella* and *Phœnix acaulis*. The main grass

is *Anthisteria ciliata*. The regeneration is good. The outstanding features of the sub-type are light weed growth and adequate regeneration.

(3) *B2(b) – South Raipur Sal*—It occurs on crystalline rocks with yellow loam soils. The quality class is M.P. II (90–70 feet). The selected characteristic associated species in the top canopy are *Pterocarpus marsupium* and *Terminalia tomentosa*, and in lower canopies *Phyllanthus emblica*. The main grass is *Anthisteria ciliata*. Regeneration is satisfactory. The outstanding features of the sub-type are, undergrowth of moderate grass, and shrub growth light.

(4) *B2(c) – Singhbhum Valley Sal*—It occurs on wash from crystalline rocks, which is a deep loam. The quality class is M.P. I (over 90 feet). The selected characteristic associated species in the top canopy is *Terminalia tomentosa*, and in the lower canopies *Flemingia chappar* and *Indigofera pulchella*. The main grasses are *Imperata arundinacea* and *Anthisteria imberbis*. Regeneration is excellent. The outstanding features of the sub-type are moderate shrub growth and good regeneration.

While preparing the revised stock-maps of South Raipur Sal forests, it has been ascertained that the approximate area under each sub-type is as follows :—

Sal sub-type	Approximate area in acres
1. A3 – Dry Peninsular Sal	1,03,189
2. B2 – Moist Peninsular Sal	14,332
3. B2(b) – South Raipur Sal	31,947
4. B2(c) – Singhbhum Valley Sal	7,204
Total Sal Area ..	1,56,672

These figures indicate that, by far, the commonest sub-type is Dry Peninsular Sal, but being not important from management point of view, it is not dealt with in this paper. It may, however, be remarked that this sub-type does occur on dry shallow soils which are subjected to erosion. The trees seldom reach the height of 70 feet. The main range is between 50–60 feet. Bole is mostly distorted, crowns poorly developed, density low and general condition moribund. The common associates in the top canopy are *Anogeissus latifolia*, *Terminalia tomentosa* and *Boswellia serrata*. In the lower canopy *Diospyros melanoxylon*, *Buchanania lanzan* and *Gardenia turgida* are commonest. *Woodfordia floribunda* becomes gregarious locally, especially on badly eroded areas. Sal never forms pure stands and consociations of *Anogeissus latifolia* and *Boswellia serrata* are very frequently met with. *Ischæmum angustifolium* and *Anthisteria ciliata* cover the forest floor completely. *Dendrocalamus strictus* is *never* found and regeneration is particularly scanty.

The next dominant sub-type is South Raipur Sal. It is, by far, the most important sub-type in South Raipur Division, specially from management point of view. This paper is intended to deal with this sub-type in particular.

The occurrence of Moist Peninsular Sal, however, is poorly defined in this Division. It frequently merges imperceptibly into Singhbhum Valley Sal on one side and South Raipur Sal on the other.

The distribution of Singhbhum Valley Sal is very limited. Here Sal attains gigantic size and *Terminalia tomentosa* and *Anogeissus latifolia* always appear in the top canopy with it. *Boswellia serrata* and *Bombax malabaricum* frequently occur fringing this type. Regeneration may be said as fair only. Usually the forest floor remains clean so long as the top canopy is not broken. Scanty unestablished Sal regeneration develops frequently. If the top canopy

is heavily opened up *Imperata arundinacea* and other coarse grasses cover the ground thickly and to the exclusion of all other species. Climbers, as well, become prolific.

In South Raipur Division, the chief geological formations on which South Raipur sub-type Sal occurs, are massive granites, syenites and dioritic rocks. Gneiss, schists and arkose are common but the greater area carries hornblende-gneiss. Pegmatite occurs locally. The soils derived are predominantly arenaceous with a fair admixture of argillaceous matter. They are, thus, loamy sands and yellowish in colour. Humified layer is rather thin, soil moisture low and aeration good. The average statistical data of rainfall and temperature is as follows :—

Month	Rain fall in inches	Maximum Temp. in degrees Fah.	Minimum Temp. in degrees Fah.
January	0·67	82·2	53·8
February	0·01	88·2	62·1
March	0·34	97·6	69·9
April	0·02	102·7	78·7
May	0·37	107·7	83·0
June	9·68	94·1	77·0
July	11·72	87·0	77·1
August	21·38	84·9	74·7
September	5·67	88·4	74·5
October	1·07	90·4	71·8
November	2·71	85·0	63·9
December	0·00	82·7	59·7
TOTAL ..	53·64		

Other climatic features are, no severe frost, heavy dew and occasional drought.

To study the ecological status of South Raipur Sal sub-type, compartment No. 371 of Birguri Range was chosen. Here the ground is perfectly flat, soil is deep yellow sandy loam with fair infiltration of humus and Sal is M.P. II quality and a typical representation of South Raipur Sal sub-type. Crop is middle-aged, well grown and healthy. An ecological transect was run through this compartment in East–West direction and in all 62 quadrats were studied on 20th and 21st May, 1951. Each quadrat was 30 feet square. The general form of laying out the quadrats was as given in Fig. 1 below :—

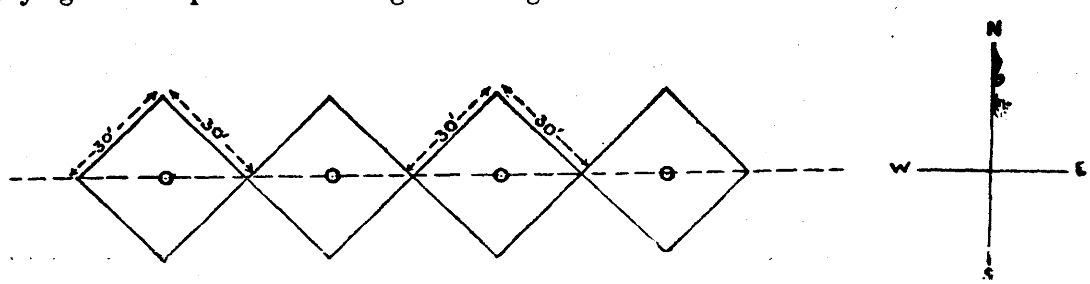

FIG. I.

This method was found to be most convenient and quick. In each quadrat all trees, shrubs and herbs were counted by species and their position in the forest profile was recorded. At the centre of each quadrat, tests with B.D.H. soil indicator were carried out to determine the soil acidity.

South Raipur Sal sub-type has definite stratification. The uppermost stratum is 70–90 feet above ground-level. This is the top canopy. Second stratum is just below the

top canopy and is at a height of 50–60 feet. It is the lower canopy. Near the ground, shrubby cover is distinct and its height is from 15 to 25 feet. On the forest floor, the ground cover is 2–3 feet high.

The field data was analysed and the resultant valence histogram is shown in Fig. 2.

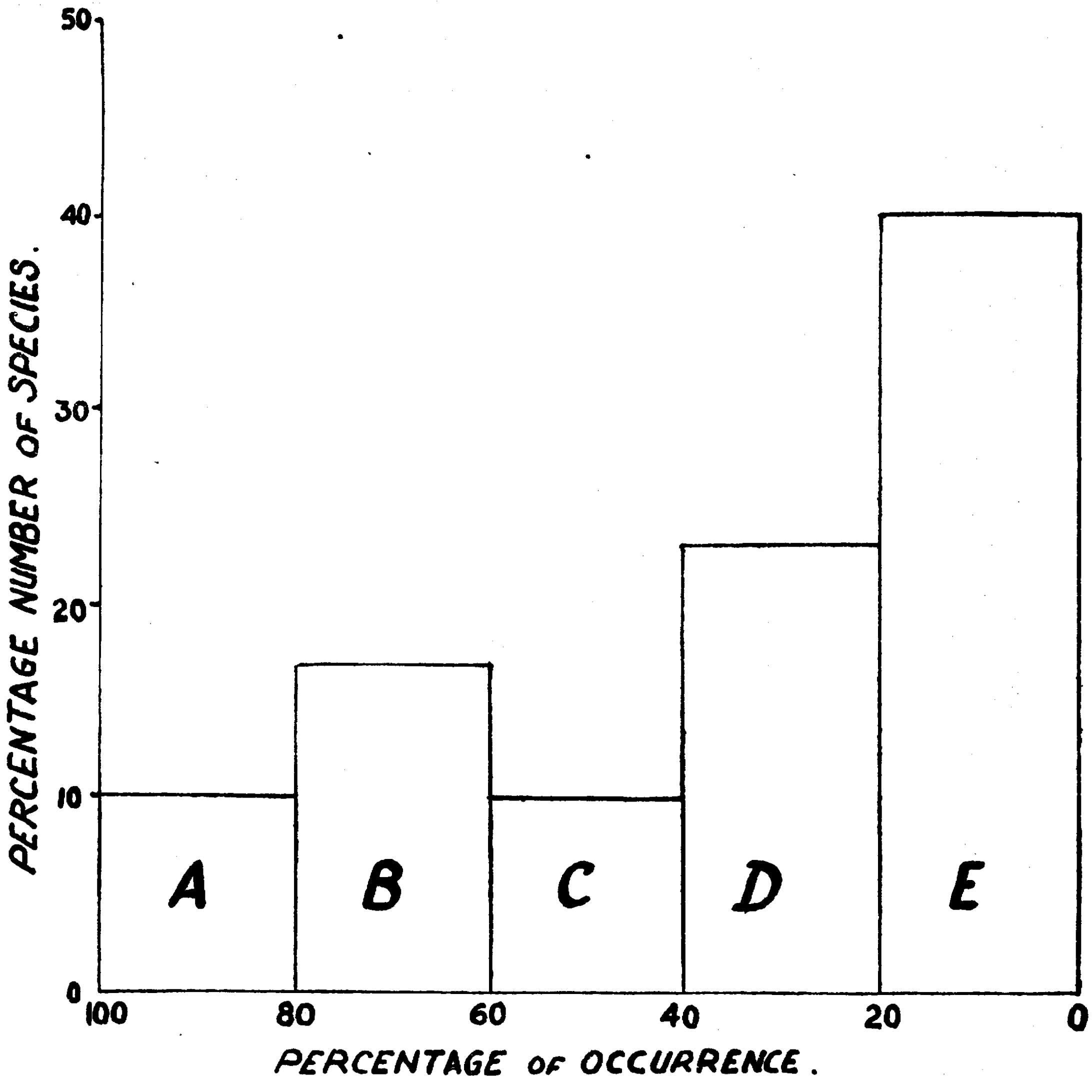

FIG. 2.

A = *Shorea robusta, Buchanania lanzan, Emblica officinalis.*

B = *Buchanania angustifolia, Diospyros melanoxylon, Bauhinia malabarica, Emblica robusta, Cassia fistula.*

C = *Semecarpus anacardium, Terminalia chebula, Terminalia tomentosa.*

D = *Madhuca latifolia, Randia dumetorum, Casearia graveolens, Gardenia gummifera, Eugenia jambolana, Randia uliginosa, Kydia calycina.*

E = *Lagerstrœmia parviflora, Terminalia belerica, Schleichera oleosa, Adina cordifolia, Grewia sapida, Ougeinia dalbergioides, Pterocarpus marsupium, Bridelia retusa, Gardenia turgida, Gelonium lanceolatum, Stephegyne parvifolia, Anogeissus latifolia.*

Percentage abundance, maximum number of plants per acre and percentage stratification, i.e., the percentage of each species in different strata of forest profile, were also calculated from the field data and the results obtained are tabulated below :—

Species	Valence	Abundance	Maximum No. of plants per acre	Percentage Stratification			
				Top canopy (70′–90′)	Lower canopy (50′–60′)	Shrubby cover (15′–25′)	Ground cover (2′–3′)
Shorea robusta ..	100	19·4	371	30·8	27·4	10·5	31·3
Semecarpus anacardium ..	52	1·7	86	..	5·0	70·0	25·0
Madhuca latifolia ..	40	2·5	96	10·0	5·0	70·0	15·0
Buchanania lanzan ..	100	14·2	335	..	12·8	37·2	50·0
Terminalia chebula ..	58	1·6	62	..	16·6	25·0	58·4
Buchanania angustifolia ..	73	2·2	72	..	..	56·2	43·8
Terminalia tomentosa ..	59	1·4	62	16·7	..	25·0	58·3
Emblica officinalias ..	100	11·7	235	9·0	17·3	20·9	52·8
Diospyros melanoxylon ..	79	16·3	533	..	..	22·0	78·0
Bauhinia malabarica ..	77	5·9	129	..	5·5	26·8	67·7
Emblica robusta ..	69	3·9	130	..	..	35·5	64·5
Randia dumetorum ..	39	1·6	77	..	..	20·0	80·0
Lagerstrœmia parviflora ..	8	0·1	48	..	..	..	100·0
Cassia fistula ..	75	2·6	72	..	5·5	22·0	72·3
Terminalia belerica ..	19	0·7	72	..	..	..	100·0
Casearia graveolens ..	35	0·7	48	..	..	..	100·0
Schleichera oleosa ..	19	1·5	125	..	..	6·6	93·4
Gardenia gummifera ..	39	1·8	82	..	12·5	12·5	75·0
Eugenia jambolana ..	32	0·7	48	..	..	33·4	66·6
Randia uliginosa ..	30	1·9	144	..	12·5	46·5	41·0
Adina cordifolia ..	9	0·2	48	..	..	..	100·0
Grewia sapida ..	7	0·2	48	..	..	..	100·0
Ougeinia dalbergioides ..	20	2·0	192	..	..	28·0	72·0
Pterocarpus marsupium ..	20	0·5	48	50·0	..	..	50·0
Bridelia retusa ..	9	0·5	96	..	..	..	100·0
Kydia calycina ..	36	1·2	82	..	12·5	12·5	75·0
Gardenia turgida ..	8	0·1	48	..	100·0	..	..
Gelonium lanceolatum ..	8	0·3	48	..	50·0	50·0	..
Stephegyne parvifolia ..	16	1·8	120	..	62·5	..	37·5
Anogeissus latifolia ..	10	0·6	72	..	..	50·0	50·0

NOTE :—The average number of plants per acre is 2,266 which is the total for all four strata.

The above figures may be interpreted thus :

(1) Considering both, valence and abundance, the gradation of species with regard to the frequency of occurrence of abundance is :—

Shorea robusta, Buchanania lanzan, Diospyros melanoxylon, Emblica officinalis, Bauhinia malabarica, Emblica robusta, Cassia fistula, Buchanania angustifolia, Madhuca latifolia, Terminalia chebula, Semercarpus anacardium, Terminalia tomentosa, Gardenia gummifera, Randia dumetorum, Randia uliginosa, Kydia calycina, Ougeinia dalbergioides, Schleichera oleosa, Stephegyne parvifolia, Casearia graveolens, Eugenia jambolana, Terminalia belerica, Pterocarpus marsupium, Anogeissus latifolia, Bridelia retusa, Adina cordifolia, Gelonium lanceolatum, Grewia sapida, Gardenia turgida and *Lagerstrœmia parviflora.*

(2) Considering the percentage stratification and valence, the gradation of various species in different strata is as follows :—

In the top canopy—*Shorea robusta, Pterocarpus marsupium, Terminalia tomentosa, Emblica officinalis*, and *Madhuca latifolia.*

In the lower canopy—*Shorea robusta, Emblica officinalis, Buchanania lanzan, Stephegyne parvifolia, Terminalia chebula, Gardenia turgida, Gardenia gummifera, Kydia calycina, Bauhinia malabarica, Cassia fistula, Gelonium lanceolatum, Randia uliginosa, Semecarpus anacardium*, and *Madhuca latifolia.*

In the shrubby cover—*Buchanania angustifolia, Buchanania lanzan, Semecarpus anacardium, Madhuca latifolia, Emblica robusta, Emblica officinalis, Bauhinia malabarica, Diospyros melanoxylon, Cassia fistula, Terminalia tomentosa, Terminalia chebula, Randia uliginosa, Eugenia jambolana, Shorea robusta, Randia dumetorum, Ougeinia dalbergioides, Anogeissus latifolia, Gardenia gummifera, Kydia calycina, Gelonium lanceolatum*, and *Schleichera oleosa.*

In the ground cover—*Diospyros melanoxylon, Cassia fistula, Emblica officinalis, Bauhinia malabarica, Buchanania lanzan, Emblica robusta, Kydia calycina, Casearia graveolens, Terminalia tomentosa, Terminalia chebula, Buchanania angustifolia, Shorea robusta, Randia dumetorum, Gardenia gummifera, Eugenia jambolana, Terminalia belerica, Schleichera oleosa, Ougeinia dalbergioides, Semecarpus anacardium, Randia uliginosa, Pterocarpus marsupium, Adina cordifolia, Bridelia retusa, Lagerstrœmia parviflora, Grewia sapida, Madhuca latifolia, Stephegyne parvifolia* and *Anogeissus latifolia.*

From these lists it may be seen that Sal is the predominant species and in the top canopy its characteristic associates are *Pterocarpus marsupium* and *Terminalia tomentosa.* This confirms Shri Champion's view. In the lower canopy, however, the characteristic associate is not only *Emblica officinalis* (as given by Shri Champion) but also *Buchanania lanzan.* This is the modification required in Champion's description. In fact *Buchanania lanzan* contributes a very significant physiognomic character to South Raipur Sal by its evergreen nature and high susceptibility to frost. The moderate cover of lower canopy is characterized by the preponderance of suppressed Sal and species like *Buchanania angustifolia, Shorea robusta, Cassia fistula* and *Bauhinia malabarica.* Very often Sal tends to produce pure stands in top canopy and occasionally mainly with *Pterocarpus marsupium.* Thus the main plant communities in the top canopy of South Raipur Sal are (*a*) *Pure Sal community* and (*b*) *Sal – Pterocarpus marsupium* community. Sal reproduction is comparatively better in the latter community. The plant communities occurring in the lower storey, or societies as they may be called, are (*a*) *Sal – Emblica officinalis* community, (*b*) *Sal – Buchanania lanzan*

community, (*c*) *Sal – Gardenia gummifera – Gardenia turgida* community, and (*d*) *Sal – Randia dumetorum* community. Out of these four dominated communities, it is *Sal – Emblica officinalis* community which is most important from management point of view. It is under this community that we find comparatively abundant recruitment, establishment and development of Sal advance growth. Once the established Sal advance growth has fully stocked the forest floor, both overwood and underwood may be removed completely in one operation. In some cases, however, due to heavy shade or other adverse locality factors, the Sal advance growth, though existent, remains only unestablished, at the maturity of the crop. Here the manipulation of overhead canopy is required in the following ways : (*a*) If the advance growth is sparsely stocked and unestablished, Sal associates in the top canopy are removed and also the malformed and whippy specimens of Sal. The amount of opening thus provided in the top canopy induces the Sal advance growth to fully stock the area. (*b*) If the advance growth is fully stocked but unestablished, Sal associates in the top canopy are removed, together with a large proportion of Sal itself. Usually well formed, mature and healthy specimens are retained. Along with this operation, manipulation of lower canopy is also essential. Most of the suppressed, malformed and moribund Sal is removed and a judicious thinning in *Emblica officinalis* is made wherever it is congested, otherwise it is left intact. The amount of manipulation in *Emblica officinalis* canopy, however, directly corresponds with the state of progress establishment of Sal advance growth.

Sal – Gardenia gummifera – Gardenia turgida community is an edaphic community and occurs where either the soil is shallow or the soil moisture is low. This community is particularly devoid of Sal reproduction. Here all the efforts of canopy manipulation, soil – working, etc., fail to bring about Sal reproduction. The extent of this community is very limited in South Raipur Sal forest and it occurs in small groups widely scattered about. Wherever clear-fellings on large areas are made, paying no particular heed to the occurrence of this community, miniature blanks with low grass are formed in the second growth forest, wherever this community existed previously.

Sal – Randia dumetorum is another edaphic community and occurs in low-lying places where soil moisture is excessive, and the area might get water-logged in rains. This is another community in which Sal reproduction appears with difficulty. Usually the Sal advance growth in this community is thinly stocked and unestablished. Heavy opening in the top canopy and also removing certain percentage of Sal in the lower canopy (depending on the amount of stocking and degree of establishment of the Sal advance growth) but not touching *Randia dumetorum*, brings about the establishment of at least existing advance growth, if at all it fails to induce further recruitment.

Sal – Buchanania lanzan community comes just next to *Sal – Emblica officinalis* community, from management point of view. Very often in this community the Sal advance growth is fully stocked but usually unestablished. Here heavy opening, both in the top – and lower canopy brings about establishment of reproduction.

In the shrubby cover, *Buchanania angustifolia*, *Bauhinia malabarica*, *Emblica robusta*, *Cassia fistula* and *Randia uliginosa* form almost pure communities. Merging of one community into another, often, produces admixture. *Emblica robusta* community is, by far, the best from Sal regeneration point of view. Here Sal advance growth, fully stocked and established, is the common feature. The gradation of other communites with regard to Sal reproduction is – *Buchanania angustifolia* community, *Bauhinia malabarica* community, *Cassia fistula* community and *Randia uliginosa* community. The last named community is often devoid of all Sal reproduction.

In the ground cover, prevalent society of *Indigofera arborea* and aspect society of *Flemingia nana* are common. The latter society indicates sites favourable for the spread and

establishment of Sal advance growth. The former becomes abundantly conspicuous if the areas with deficient Sal advance growth are heavily opened up. The gregariousness of *Indigofera arborea* arrests the progressive recruitment of Sal reproduction. Also, the clans of *Lagerstrœmia parviflora, Anogeissus latifolia, Adina cordifolia* and *Terminalia belerica* are often observed in the ground cover.

South Raipur Sal regenerates well. It may have abundant established advance growth if the crop is well-tended throughout its life. In mature stands but with no established advance growth, both recruitment and establishment of Sal reproduction are secured if the interfering adverse ecological factors such as constant annual fires and heavy grazing are controlled. The ecological tendency of South Raipur Sal is to produce abundant established advance growth only when the crop is just maturing or is mature. During middle period of the life of this forest, regeneration of miscellaneous species, such as *Diospyros melanoxylon, Emblica officinalis, Buchanania lanzan, Kydia calycina, Terminalia tomentosa, Terminalia chebula,* and *Buchanania angustifolia,* has the upper hand. Any effort to obtain Sal reproduction in immature South Raipur Sal forest, results in the preponderance of miscellaneous species. Even in Intermediate Periodic Block areas where Sal is immature, a heavy opening of the canopy arrests the progressive recruitment and development of Sal reproduction. In this case, if miscellaneous species do not come up abundantly, grass takes the lead. This is particularly the outstanding feature in Sal forests of South Raipur Division, at present. This condition has resulted as a natural consequence of sleeper-bound attitude of Divisional Staff during last twenty-five years. To achieve the maximum sleeper production, indiscriminate fellings in the Intermediate Periodic block areas were made and the net results, now evident, are (*a*) Growing stock is particularly deficient in larger diameter classes and (*b*) heavy grass is the only ground flora.

Compartments No. 366 and 367 of Birguri Range (South Raipur Division) may be cited as examples of converting thoroughly the immature South Raipur Sal. These compartments were allotted to P.B. II by Shri C. M. Harlow in 1924. Shri Stein, while revising the working plan of these Sal forests in 1934, wisely continued these compartments in P.B. II, but the unthoughtful action of Divisional Staff carried out clear-fellings in these compartments in 1944 and 1943 respectively. The second growth forest, now, contains predominantly miscellaneous species with a very low percentage of Sal, and that too is of coppice origin. The mistake committed in not following the course of nature, has upset the balance and the valuable Sal forest is converted to practically worthless miscellaneous forest.

The soil acidity tests which were carried out with B.D.H. Soil Indicator show that the range of acidity is from 5·5 to 7·0 pH. The prevalent pH value is 6·5 and it may be regarded as normal for South Raipur Sal. The maximum acidity of 5·5 is reached in areas *where shrub growth is practically absent or is cut, and annual fires prevalent.* Where crop is over-congested the acidity test is neutral (pH 7·0).

A METHOD TO INDICATE THE PERCENTAGE OF LAND WHICH SHOULD BE UNDER FOREST : SOME COMMENTS

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1. In his article of the above title in the *Indian Forester*, the editor, has made some very useful suggestions on determination of the proportions of land which should remain under forests in hilly and plain areas*. The method suggested by him for hilly areas would prove to be a useful guide for foresters, administrators and others who need to have an approximate idea of the areas which should be under forests and other uses in particular areas. The method, as the author has himself pointed out, can give only approximate results. But its value will be appreciated when it is borne in mind that data on soils and other characteristics by which land use capability may be accurately determined are very meagre (virtually non-existent in most areas), and it will take several years before the necessary Surveys are conducted, and such data become available. Two observations on this method may, however, be made :

(*i*) The method is designed to give an approximate idea, *on a regional basis*, of the proportions of land which should remain under forests. It is not meant to be, and should not be used for determining whether a particular piece of land should or should not be under forests. The method relies only upon determination of slopes. Slope is undoubtedly a very important factor in determining land use capability, and perhaps the most important on a regional basis. But where specific locations are concerned, and the most suitable land use for particular areas is to be determined, one or more of the other factors determining land use capability like character of the underlying geologic formations, nature and depth of soils, drainage, etc., may be of equal or even greater importance than slope.

(*ii*) The figure of 12 per cent slope which has been used in the article is merely illustrative. It should not be taken as a criterion on the basis of which one could demarcate forest and non-forest areas. The figures of 12 to 20 per cent are, as explained by the author, based upon American experience, and he has also explained why he has chosen the former figure. In case of India, the figures would most probably be lower than these. There are two main reasons for this. Firstly, in the tropical climates of India weathering is more rapid than in the sub-tropical and temperate climates of U.S.A. Secondly, the monsoon rainfall of India is of a torrential character and is more erosive than rainfall in large parts of U.S.A. (especially Northern U.S.A.) which comes in long, gentle showers. The critical percentages would vary also in different parts of India itself. They will have to be determined by actual tests in different areas. It will not do to apply figures derived under different conditions of another country.

2. Calculations on the area which should be maintained under forests in the plains are most interesting. Here, the main consideration is supplying the needs of the population for forest produce ; physical considerations like slope are less important. According to the author, in areas having a population density of 500 persons per square mile, about 20 per cent

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* Indian Forester, Volume 78, No. 11, November 1952, pages 537–39.

of the land should be under forests in order that the needs of the population for fuel and other forest produce may be adequately met. These calculations lead to one conclusion ; the forests and tree lands (including village plantations) located within the densely populated plains can supply only a portion of the needs for forest produce ; a large part of the needs must be met by imports from other areas (or by alternative fuels, in case of fuel needs), and the higher the population density, the greater this dependence upon imports or alternative fuels. The reason for this conclusion is obvious. In most of the plains areas, where the density of population is 500 or above, a very large part of the land is taken up for cultivation (up to 80–90 per cent in many parts) and the balance is occupied mainly by grazing lands, fallows or non-agricultural uses like towns and villages, roads, canals, railways, industries, etc. The area under forests is very small, and even under a well planned system of land use, it can be increased only to a limited extent. Take West Bengal plain for an example. Population density is nearly 1,000 per square mile. On the basis of the above calculations, nearly 40 per cent of the land would be needed for forests. But the area at present reported under forests is only 6 per cent of the total. 61 per cent of the land is under cultivation, 6 per cent is under fallows and the balance is waste or is occupied by non-agricultural uses. Obviously, it is not possible to obtain any thing like the requisite percentage of 40 per cent under forests in this area as the needs of agriculture, settlements, industries and transport are much more important. The situation in other densely populated areas, like U.P., Bihar and the plains of East and West Coast is essentially similar. Requirements of fuel and forest produce are very large because of the large populations, but as very high proportions of land are occupied by agriculture and other uses areas under forests are small and cannot be greatly increased.

3. This is not to deny the need for creation of tree plantation close to villages, or of bringing under forests all waste or idle lands in the plains. These measures are very necessary both for reducing dependence upon imports and for preservation of proper physical conditions and conservation of the resources of soil and water. But it must be recognized that these measures, necessary though they are, provide only a partial solution of the problem of supplies of fuel and other forest products in most densely populated plains.

4. It is but natural, that the demand for forest produce from the plains should impinge first and most heavily on forests in the marginal zones between the plains and the mountains or plateaus (the foot-hill zone of the Himalayas and the lower slopes of the plateaus and hills of Peninsular India), which are nearest the concentrations of populations. Forests in these zones would be the first to be exploited and would also be under constant pressure for larger and larger supplies, because supplies from such forests would be the cheapest. These forests would quickly disappear, as they have done in many parts of the country, unless exploitation is carefully regulated, and constant vigilance is exercised for their protection. But preservation of forests in these areas is most urgent in order to protect the plains from soil erosion, floods, silting of streams and fertile croplands, desiccation, etc. The problem is thus a complex one. The short term interest of gettting supplies at the lowest price possible and the long term need for conservation of natural resources are in conflict in these marginal zones, and only with the most careful regulation can forests in such areas be protected from depletion.

5. The solution of the problem of supplies of fuel and other forest produce has to be worked out separately for each region, depending upon the particular conditions in the region. In those regions, where large tracts of forested lands in the plateau or hilly areas are located close to the plains, these lands can supply the needs of the plains to a large extent. The plains and their adjoining plateau or hill lands can thus be visualized as composing one unit, the two parts of which are complementary to each other. The Malabar-Konkan Coastal Plain and the Western Ghats, the Chota Nagpur Plateau and the plains that surround it in North Bihar and West Bengal are examples of such complementary regions.

As the demands for fuel especially are very large, use of alternative fuels to supplement fire-wood appears to be necessary in most areas. In Bengal, Bihar, U.P. and other areas situated close to the coalfields, soft coke provides a suitable alternative fuel and its use should be encouraged as much as possible. In Southern and Western India, however, where distances from the coalfields are long and the cost of transport of soft coke is very high, the problem is more difficult. Development of hydro-electricity and of locally available fuel deposits, like the S. Arcot lignites, offer fruitful lines of approach for these areas.

WOODEN FLOOR FOR THE SQUASH COURT AT NEW FOREST

BY A. C. SEKHAR

Wooden floors are of different kinds. Their design depends upon various considerations such as their utility, normal types of loads they are intended to carry, and architectural and other structural considerations. The cost of laying a floor is also a major consideration. In the most common floors, dressed and matched materials, surfaced both sides, are nailed direct to the supporting members. Tongue and groove matching is almost entirely used. A diagonal bracing sometimes helps to reduce the vibrations and distribute the floor loads evenly.

The dimensions of a Squash Court are 32 feet lengthwise and 21 feet breadthwise, and its flooring has to be washed quite frequently. In the design of the floor for the Squash Court at New Forest, it was decided to lay planks on bearing members (joists) fixed across the floor. It was also decided to avoid costly timbers like teak and try some of the species hitherto not very popular for use in wooden flooring, but otherwise hard enough against wear caused by trampling. Such timbers usually experience considerable shrinkage and swelling due to changes in atmospheric temperature and humidity. Therefore, it was necessary to provide against any inconvenience to, day-to-day play on account of the shrinkage and swelling of the entire floor.

With the above objects in view, some preliminary experiments were conducted to determine the best type of joints between the planks and the best type of fixing the planks to the joists. Various designs as shown in Fig. 1 were made with the cleats of the types A and B (Figs. 2–3) fixed to the planks and joists. Cleats of the type A (Fig. 2) were designed to hold the different planks together so that the entire floor would behave as one unit in shrinkage and swelling. Cleats of the type B (Fig. 3) serve two purposes : (1) to anchor down the planks to the joists and to slide along a groove made in the joists so that swelling and shrinkage may easily take place without any warp on the floor boards. These designs made on a laboratory scale were subjected to severe conditions of weather by alternately drying in the hot sun and keeping immersed in water for one or two weeks. The object of this test was purely to test the relative efficacy of the cleats used for wooden floors with different types of matched planks.

Of the different types of matching the edges of planks as indicated in Fig. 1, it was observed that type (*a*) was beyond the most economical and the simplest taking into consideration shrinkage and swelling. But it was considered that the other types would be more suitable from the point of view of strength and of the inter-space between the planks. If there is any such inter-space between the planks, a through opening will be observed in type (*a*) and this is avoided in the other types. Type (*c*) and type (*d*) require about the same effort in working on machine, but type (*c*) requires greater precision and would delay the actual laying of the floor. The defect of type (*b*) is that one plank was found to slide over the other when subjected to swelling and shrinkage tests, although it does not show a through opening in the flooring when the planks get slightly separated from each other. For these considerations, type (*d*) was considered to be the best, though the cleats gave quite satisfactory results in all the cases except in type (*b*).

For the actual laying of the floor in the Squash Court, *kindal* (*Terminalia paniculata*) and *poon* (*Calophyllum tomentosum*) were chosen. The joists were made of *poon* and the planks, of both the species. The sizes of sections converted in saw-mill from 12 logs of *kindal*,

257 c. ft. in volume and from 8 logs of *poon*, 209 c. ft. in volume are indicated in Table I. Saw-mill conversion data indicate that the yield of the grade of timber suitable for joists and planks for flooring is as low as 33% in the case of *kindal* and about 50% in the case of *poon*. The low yield in the case of *kindal* was due to the presence of large number of cracks, and deteriorated material in the logs. Log-breaking was undertaken on a 4″-band-saw and further reconversion was done on a 36″-circular-saw (Wadkin's). After conversion the timber were first seasoned for about 3 weeks reducing the moisture content to 15% and subsequently the necessary woodwork, like planing of the planks, rebating, grooving and reducing to the correct dimensions, was undertaken on the woodworking machinery in Service Branch. The planks and scantlings were treated with wood preservatives and then redried to about 12% m.c. The average coefficient of shrinkage for *poon* and *kindal* worked out to 0·3 per unit change in the percentage of moisture content.

The joists were fixed to the concrete floor by means of screws to wooden pegs imbedded in the floor, as shown in Figs. 4 and 5 (1), thus departing from the normal method of fixing the joists to the concrete floor by means of bolts and nuts. It was considered that this method would not only save the use of iron bolts and nuts, but also present an easier method of fixing the joists directly on the concrete floor. This would enable easy and quick removal or replacement when required. The joists were laid along the breadth of the court at intervals of 2 ft. on the ground, with only one joint at the centre as shown in Fig. (4). A groove runs right along the length of the joists so that cleats of the B-Type (Fig. 3) easily slide in the groove [Ref. Fig. 5 (1)]. The planks of *poon* and *kindal* were alternatively placed on the joists in the direction of the length of the court and fixed underneath by means of cleats A and B [Ref. Fig. 5 (1), 5 (2) and 5 (3)]. A cross-sectional view of the entire floor, with a clearance nearly 1 inch in the walls to facilitate possible expansion of the flooring, is shown in Fig. 4. While the planks on either side of the central piece were simply half-lap jointed to each other, the central plank was screwed down to the joists and matched to its immediately adjacent planks by grooved lap. This was necessary, as it was not possible to fix the cleats to the last plank from underneath. This method would also ensure uniform shrinkage and swelling on either side of the central plank. A preliminary investigation in standard testing machine by fixing cleat of the type A (Fig. 2) on two separate pieces of wood (Ref. Fig. 6) and pulling them apart, revealed that on an average, these cleats took about 350 lbs. before failure. This ensured that one cleat of type A between each spacing of joists would be normally sufficient to take up the stresses caused by shrinkage and swelling of the floor boards. Actually, however, the cleats were generally spaced as indicated in Fig. 5 (2).

The cost involved in laying the floor is briefly indicated in Table II.

Acknowledgements are due to the Wood Seasoning Branch and the Wood Preservation Branch for kindly seasoning and treating the timber with wood preservatives and to the Wood Workshop (Service Branch) for doing all the woodwork and assisting in laying the floor.

TABLE I

Out-turn of utilizable material for floor boards and joints

Kindal

$1\frac{1}{2}'' \times 6\frac{1}{2}'' \times 8\frac{1}{4}'$	86	48	c. ft.
$1\frac{1}{2}'' \times 6\frac{1}{2}'' \times 4\frac{1}{4}'$	50	15·4	c. ft.
$1\frac{1}{2}'' \times 4\frac{1}{2}'' \times 8\frac{1}{4}'$	40	15·5	c. ft.
$1\frac{1}{2}'' \times 4\frac{1}{2}'' \times 4\frac{1}{4}'$	26	5·2	c. ft.
Total		84·1	c. ft.

(contd.)

TABLE I—(*concld.*)

Out-turn of utilizable material for floor boards and joints

Poon

$3\frac{1}{4}'' \times 3\frac{3}{4}'' \times 12'$	40	40·6 c. ft.
$1\frac{1}{2}'' \times 6\frac{1}{2}'' \times 8\frac{1}{4}'$	70	39·1 c. ft.
$1\frac{1}{2}'' \times 6\frac{1}{2}'' \times 4\frac{1}{4}'$	32	9·2 c. ft.
$1\frac{1}{2}'' \times 6\frac{1}{2}'' \times 3\frac{1}{2}'$	12	2·8 c. ft.
$1\frac{1}{2}'' \times 4\frac{1}{2}'' \times 8\frac{1}{4}'$	9	3·5 c. ft.
$1\frac{1}{2}'' \times 4\frac{1}{2}'' \times 4\frac{1}{4}'$	9	1·8 c. ft.
$1\frac{1}{2}'' \times 6\frac{1}{2}'' \times 2'$	18	2·4 c. ft.
	Total	99·4 c. ft.

TABLE II

	Rs.	As.	Ps.
Cost of timber including conversion costs, etc.	1,900	0	0
Cost of seasoning and preservation*	160	0	0
Cost of working on machines	50	0	0
Cost of laying the floor including masonary, carpentry and cooly labour	650	0	0
Cost of screws, etc.	110	0	0
TOTAL	2,870	0	0

* Cost of preservation of these species depends on the percentage of the amount of sapwood present in the lot and can be roughly estimated at Re. 1/- to Rs. 1/8/- per c. ft. of sapwood present.

PURIFICATION OF CAMPHOR BY SUBLIMATION

BY B. S. VARMA AND S. V. PUNTAMBEKAR
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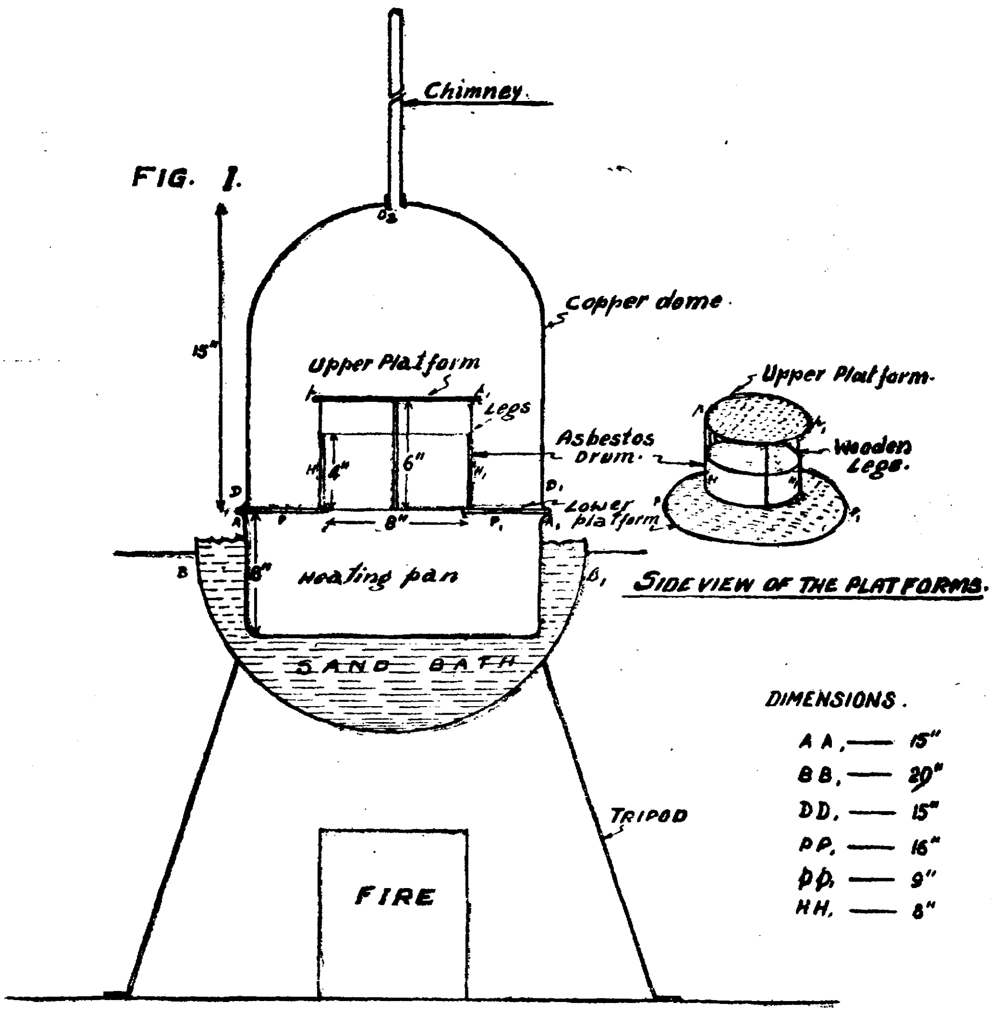
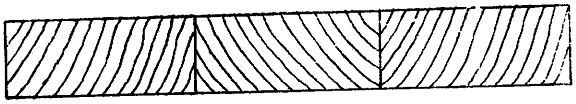
Purification of camphor can either be achieved by crystallization or by sublimation. The former method involves a number of operations such as dissolution of the camphor in a suitable solvent, filtration, and subsequent distillation of the filtrate both for the purpose of concentration and recovery of the solvent. Sublimation on the other hand is a one-step operation, quite easy, efficient and simple, provided a safe and a fool-proof sublimation apparatus is available and necessary conditions of temperature, draft, etc., determined. A number

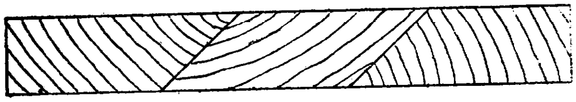
FIG. 1.



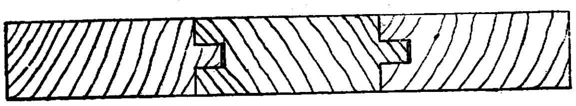
CAMPHOR SUBLIMATION APPARATUS.



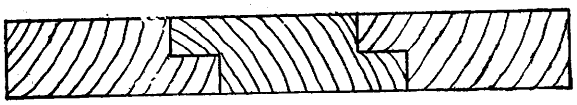
(a) SIMPLE BUTT JOINT



(b) MITERED BUTT JOINT



(c) TONGUE & GROOVE JOINT



(d) HALF-LAP JOINT

FIG. 1.

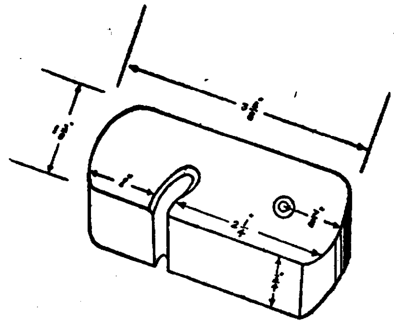


FIG. 2. CLEAT TYPE. A.

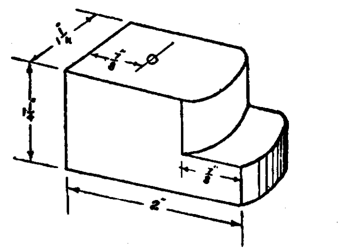


FIG. 3. CLEAT TYPE. B.

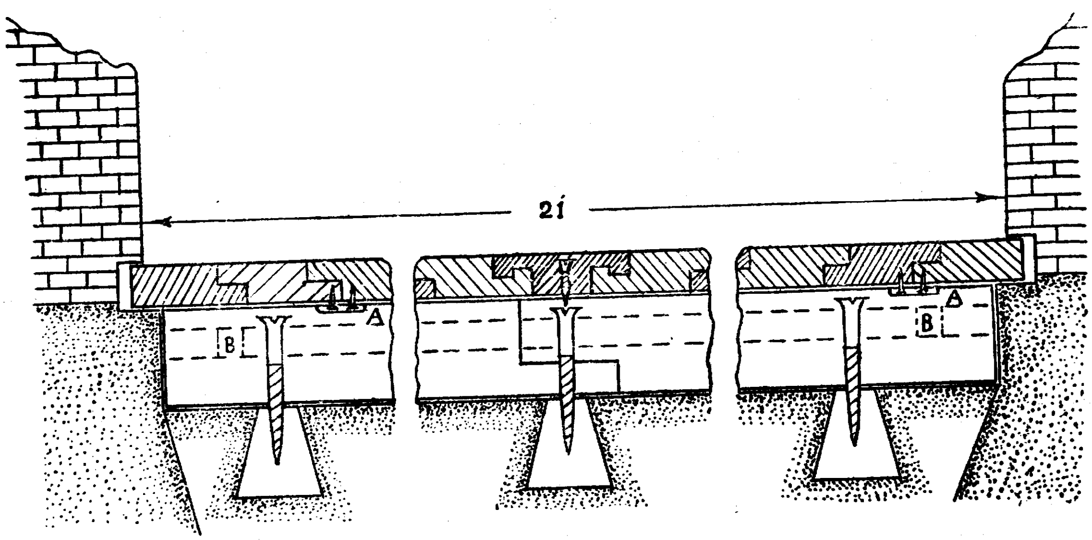


FIG. 4.

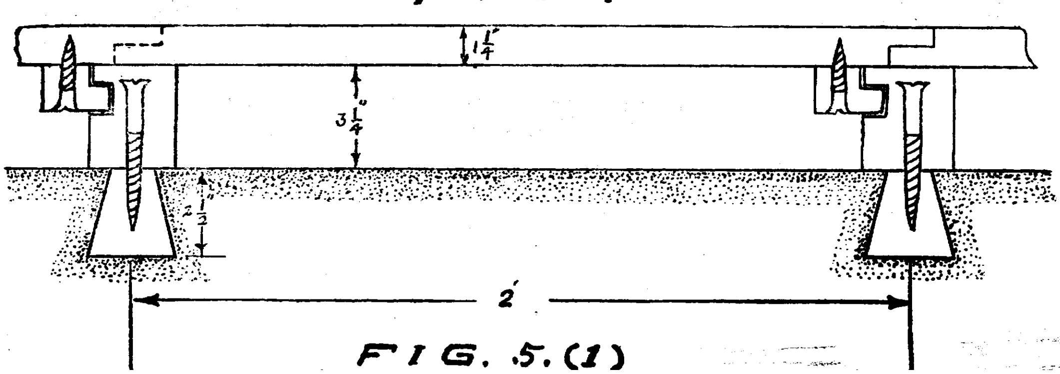


FIG. 5. (1)

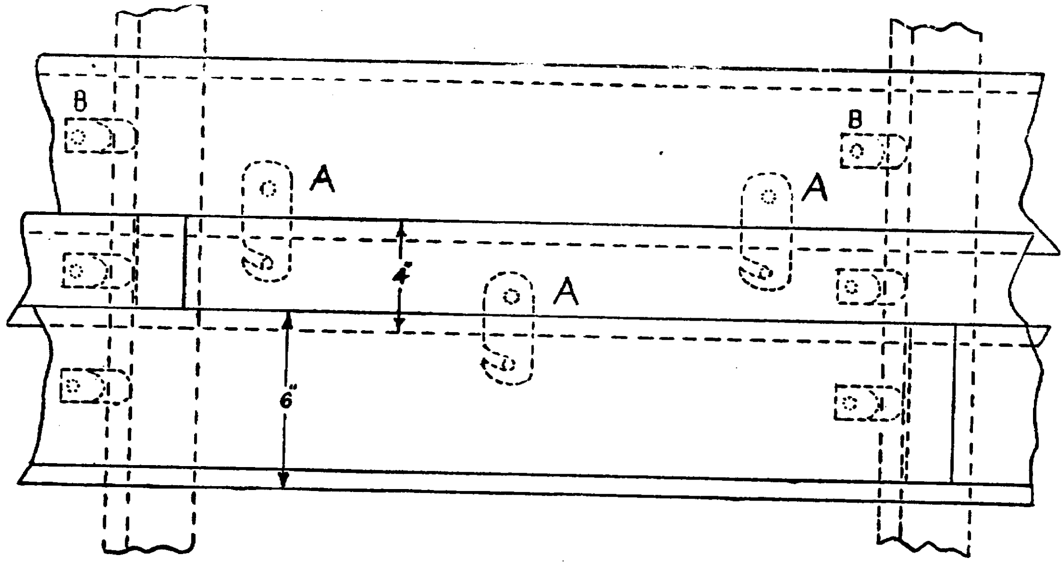
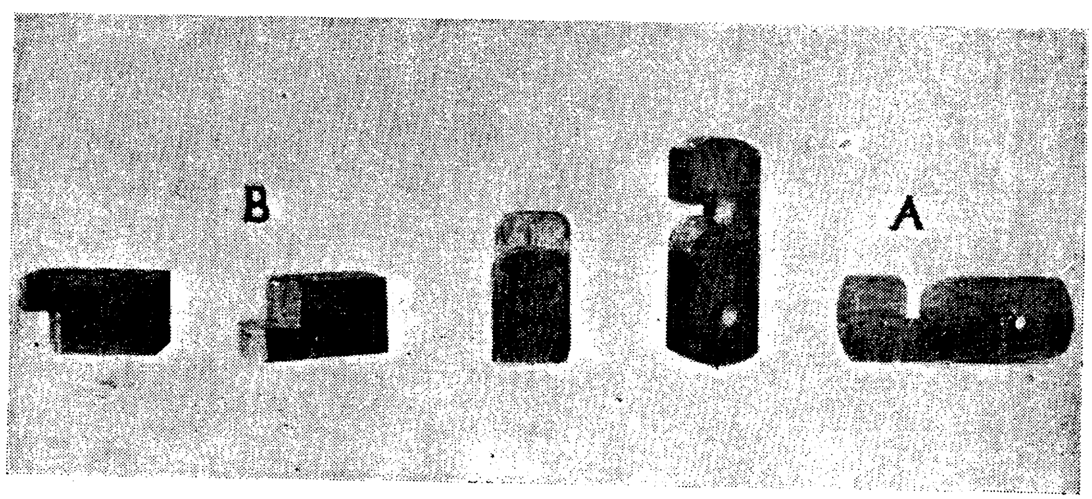


FIG. 5. (2)



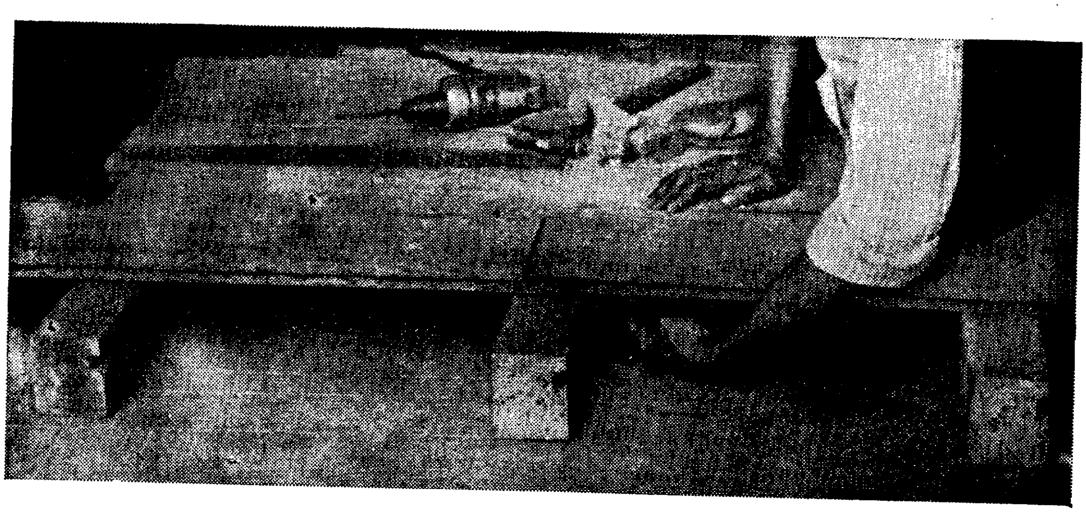


FIG. 5(3).

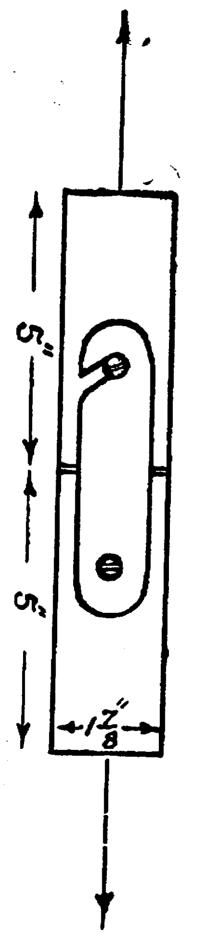


FIG. 6.

of sublimation apparatus of the type of inverted bell-jar were designed and tried, but a common difficulty in such cases was that a major part of the sublimed camphor would fall back into the heating pan, and vaporizing again. This cycle went on over and over again till a thick layer of camphor in the form of a scale was formed on the inverted bell-jar, which prolonged the operation to 6–8 days for completion. The process could be hastened by arresting the sublimed camphor from falling back into the heating pan by a special device, designed and successfully tried.

The sublimation equipment consists of a heating pan of iron AA_1 (Fig. I), 15 inches diameter and 8 inches deep, having 1/2 inch wide flange all round its rim. This pan is embedded in a sand bath contained in another bigger iron pan BB_1 the under surface of which is in contact with fire, and rests on an iron tripod. A vessel DD_1D_2 of the shape of a dome, 15 inches in diameter, 15 inches high made out from a copper sheet 1/16 inch thick, is inverted on AA_1. This dome also has 1/2 inch flange at its rim, which coincides with and rests on the flange of the heating pan. The dome is heavily tinned inside. 1 inch wide hole is made on its top into which is fixed a 30 inches long glass tube (1/2 inch to 3/4 inch wide), which serves to cause a draught and thus facilitate the rising of vapours from the heating pan. When the moisture, etc., has escaped through the tube and the camphor fumes begin to come out the tube is plugged with cotton wool on the upper end. In between the pan and the dome and held tight between the flanges, is put a round thin sheet of asbestos PP_1 of 16 inches in diameter having a hole, 8 inches in diameter in the centre. Over this opening is placed another asbestos sheet pp_1 of 9 inches diameter, and supported by four 6 inches high wooden legs. The camphor vapours rise from the heating pan, pass out by the sides of the wooden legs and strike against the wall of

FIG. II

the dome, where they coalesce into flakes and fall back. The falling flakes are arrested by and collected on the two platforms of asbestos. In order to protect the piled up flakes from slipping down from the lower platform into the heating pan, a hollow drum HH_1 of asbestos sheet, 4 inches high and of 8 inches diameter, open on both ends, is put on the mouth of the opening of the lower platform inside the four wooden legs as shown in the Figure I. When the dome is removed after the sublimation, the sublimed camphor piled up on the two platforms and supported by the drum gives the appearance of a snow mound.

The equipment of this dimension, which approximately costs Rupees 200, takes a charge of 5 lbs. of crude camphor, into which is mixed charcoal powder, slaked lime and iron fillings to the extent of 10 per cent by weight. The mixture is put in the heating pan. Direct fire is applied under the sand bath and the temperature is noted by pushing a thermometer into the sand as shown in the figure. The temperature of the sand bath is brought to 120°C. and maintained there for one hour in order to drive off the moisture, etc. By increasing the fire underneath, the temperature is then suddenly allowed to rise to 180°C. $\pm$ 10° and kept at that stage for about 24 hours. The fire is then drawn out and the outfit allowed to cool slowly overnight. Next day the dome is lifted and the sublimed product removed. By proper control of temperature and time, 70–75 per cent of sublimed camphor is recovered in the form of white flakes and 20–25 per cent as scales of white crystalline camphor. These flakes are the purest form of camphor of M.P. 178°C.

KHAIR COPPICE

BY L. S. KHANNA
Forest Ranger

Introduction—Statistics relating to coppice growth of *khair* are scanty according to Troup and the only record mentioned by him on page 457 of his book "The Silviculture of Indian Trees" relates to Madhya Pradesh and Dehra Dun for the years 1913 and 1886 respectively. The following observations made in a plantation of Ramnagar Forest Division are expected to give valuable contribution to the knowledge of the rate of growth of *khair* coppice.

An area of about 50 acres was taken up for *khair* and *semal* plantations in Phultal compartment 6, Malani Range of Ramnagar Forest Division last year. The area is an old alluvial flat with an elevation of about 1,300 feet. The soil is sandy loam, rather shallow, overlying boulders which, in places, come up to the surface. The vegetation of the area consisted of mostly mature and overmature *khair* with an admixture of occasional *dhauri*, *bahera*, *amaltas*, *bargad* and scattered *semal* and *haldu*. *Zizyphus* was in plenty as an undergrowth with *rohini* in patches – mostly under *bargad*. The area was marked in November, 1950 for felling. About 5 trees per acre were retained for protection and the felling of the rest of the crop was completed by the end of March, 1951. The area was fenced in the 1st week of June as under :—

Game-proof fence .. .. 36 acres (*khair* plot)
Cattle-proof fence .. .. 10 acres (*semal* plot)

The remaining 4 acres was left out unfenced to make plantation area rectangular.

The *khair* stumps began giving coppice shoots towards the end of April, 1951 and though some of them were browsed down by the cattle of a neighbouring cattle station during May, 1951, when the fence was not put up, their growth after fencing was remarkable, particularly when it is remembered that the monsoon had been very poor last year.

Statements showing the number of stumps, that coppiced, in 4 inches diameter classes with the height of the tallest shoot against each and the number of shoots within brackets in March, 1952, i.e., after one full growing season are given below :—

GAME PROOF FENCE

	8″–12″	12″–16″	16″–20″	20″–24″	24″ and over
	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.
	1. 7 8 (5)	1. 11 10 (6)	1. 10 7 (25)	1. 9 4 (2)	1. 13 8 (20)
	2. 7 11 (4)	2. 9 0 (3)	2. 5 0 (6)	2. 8 4 (2)	2. 10 10 (6)
	3. 8 9 (4)	3. 8 10 (9)	3. 8 10 (6)	3. 12 4 (7)	3. 10 9 (7)
	4. 7 11 (4)	4. 7 7 (2)	4. 8 9 (5)	4. 10 10 (3)	4. 10 8 (18)
	5. 9 6 (6)	5. 10 2 (8)	5. 3 9 (7)	5. 7 8 (9)	5. 9 3 (8)
	6. 8 0 (2)	6. 7 11 (4)	6. 6 10 (3)	6. 11 9 (10)	6. 7 10 (2)
	7. 12 0 (4)	7. 11 2 (3)	7. 6 11 (2)	7. 10 5 (8)	
	8. 7 8 (4)	8. 11 2 (8)	8. 8 9 (14)	8. 11 3 (16)	
		9. 10 6 (5)	9. 8 2 (7)	9. 10 2 (3)	

(*contd.*)

GAME PROOF FENCE—(*concld.*)

	8"–12"	12"–16"	16"–20"	20"–24"	24" and over
	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.
		10. 6 9 (2)	10. 9 5 (4)	10. 10 0 (14)	
		11. 7 9 (2)	11. 10 2 (4)	11. 13 10 (25)	
		12. 11 5 (7)	12. 9 4 (8)	12. 10 5 (5)	
		13. 12 9 (7)	13. 12 4 (8)	13. 12 5 (6)	
		14. 9 4 (3)	14. 8 9 (15)	14. 11 6 (11)	
		15. 9 9 (3)	15. 8 9 (7)	15. 9 11 (37)	
		16. 9 6 (1)	16. 12 7 (3)	16. 8 2 (6)	
		17. 9 6 (2)	17. 11 2 (6)	17. 9 4 (3)	
		18. 8 2 (5)	18. 9 9 (4)	18. 9 2 (6)	
		19. 5 0 (2)	19. 10 2 (4)	19. 8 6 (3)	
		20. 9 10 (10)	20. 11 6 (6)	20. 8 2 (5)	
		21. 7 2 (8)	21. 10 1 (22)		
		22. 10 0 (4)	22. 9 7 (10)		
		23. 7 8 (13)	23. 9 6 (7)		
		24. 8 2 (2)			
		25. 9 2 (11)			
		26. 8 10 (7)			
		27. 10 2 (12)			
		28. 7 6 (8)			
Total height ..	69 5 (33)	256 7 (157)	210 8 (183)	203 6 (181)	63 0 (61)
Total No. of stumps	8	28	23	20	6
Average height ..	8 8	9 2	9 2	10 2	10 6

CATTLE PROOF FENCE

	0"–8"	8"–12"	12"–16"	16"–20"	20"–24"	24" and over
	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.
	1. 8 5 (5)	1. 9 8 (8)	1. 8 0 (3)	1. 9 6 (23)	1. 11 0 (9)	1. 8 0 (6)
	2. 5 8 (2)		2. 8 0 (5)	2. 10 0 (1)	2. 9 8 (3)	2. 9 8 (5)
			3. 8 0 (1)	3. 10 8 (3)	3. 10 6 (2)	3. 5 0 (3)
			4. 13 0 (8)	4. 9 6 (4)	4. 12 6 (6)	
			5. 9 9 (1)	5. 9 11 (1)	5. 12 4 (11)	
				6. 11 2 (7)		
				7. 8 0 (12)		
Total height ..	14 1 (7)	9 8 (8)	46 9 (18)	68 9 (51)	56 0 (31)	22 8 (14)
Total No. of stumps ..	2	1	5	7	5	3
Average height	7 0	9 8	9 4	9 10	11 2	7 7

UNFENCED AREA

Diameter classes	8″–12″	12″–16″	16″–20″	20″–24″	24″ and over
Number of stumps that coppiced ..	2	4	11	2	5

Coppice of this plot was all browsed down to the ground with the result that the number of shoots and the height of coppice could not be recorded, with the exception of only 2 stumps on which one thin shoot has managed to reach a height of about 5 feet.

Number of stumps which did not coppice is tabulated below :—

Type of fencing	8″–12″	12″–16″	16″–20″	20″–24″	24″ and over
Game proof fence ..	1	7	6	2	2
Cattle proof fence ..	..	3	2	3	4
Unfenced area ..	..	1	4	1	2
Total ..	1	11	12	6	8
	GRAND TOTAL 38				

Number of stumps which coppiced is given below :—

	0″–8″	8″–12″	12″–16″	16″–20″	20″–24″	24″ and over
Game proof fence ..	..	8	28	23	20	6
Cattle proof fence ..	2	1	5	7	5	3
Unfenced area	..	2	4	11	2	5
Total ..	2	11	37	41	27	14
	GRAND TOTAL 132					

Thus out of a total of 170 stumps coppiced, 132 stumps gave out shoots giving the percentage success at 77·7%.

It is difficult to say why some of the stumps did not coppice. The method of cutting was the same in all cases being flush to the ground. Soundness has had no effect because even the gaujy stumps have coppiced. Size of stumps too had no effect because the tallest shoots were produced from stumps of 20–24 inches and 24 inches and over in diameter. At this stage, it can only be inferred from the above record that protection against wild game and cattle is essential for the successful development of *khair* coppice.

The percentage of success and the average height of the tallest shoot have been remarkable in view of the unusually dry rainy season, which had obviously no effect on the development of coppice shoots as they had the advantage of long tap root of the old stump. *Khair* coppice, therefore, commends itself for trial in places where *khair* forests are to be restocked

with *khair* to minimize cost on raising *khair* plantation. *Khair* coppice protected by game proof fence and supplemented by patch sowings (as *khair* does not grow very dense in nature) may prove economical as compared to direct sowings over the whole area and should be adopted in our plantation technique.

PLATE I

PLATE II

THE TREE SPECIES OF THE TROPICAL EVERGREEN GHAT FORESTS OF KANARA (BOMBAY) AND THEIR RATE OF GROWTH

BY G. S. MATHAUDA

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SUMMARY

Four permanent linear tree increment plots, 1 chain wide and 27·5 to 67 chains in length, were laid out in 1939 in the Eastern and Western Kanara Forest Divisions of Bombay in order to facilitate the identification of the complex tree flora of the local tropical wet evergreen forests and to determine the rate of growth of individual tree species. The information collected on these plots, during the period 1939 to 1949, forms the basis of this short note.

Out of a total of 4002 stems, 4 inches and over in b.h. diameter, 3981 have been identified. The identified stems belong to 131 different species. The number of species represented in individual plots varies from 56 to 76 and their proportion from 0·1 to 17·9 per cent. The number of natural orders varies from 26 to 32, the contribution of even the most frequent natural order being only 25·1%. The top canopy itself may be composed of 26 to 60 species, the commonest species being no more than 25·9% of the total. A detailed statement showing the number of stems for each species, in the different plots, by 4-inch diameter and 3 canopy classes is appended.

Habits of some of the species with regard to their occurrence have been examined. Whereas a few out of these occur throughout the altitudinal range of nearly 1,500 feet, others show preference for the higher or lower elevations. Again, some species are scattered all over the plots in the form of single trees or very small groups, while others are found in isolated groups of varying sizes.

It has been shown that, in each of these plots, and in the hypothetical crop represented by their averages, the numbers of trees in successive diameter classes form a geometric series, thereby proving that the law of de Liocourt with respect to balanced uneven-aged diameter distributions applies to the virgin tropical evergreen forests also. The exponential equations for the 5 above distributions have been worked out.

Mortality figures for each of the plots during the ten-year period are given. These can serve as a basis for determining the gross yield. The data examined indicate that the law of de Liocourt is applicable also to the normal mortality in these forests.

Based on the 3 quinquennial measurements which the plots have so far received, the average rates of growth of 19 most frequently occurring species have been determined and presented in tabular form.

GENERAL

1. With a view to facilitating the routine botanical identification of the complex tree flora of the Evergreen Ghat Forests of the Kanaras (S. Bombay) and to determine the rate of growth of the individual species, the Bombay Silviculturist, in collaboration with the Central Silviculturist, Forest Research Institute, Dehra Dun, laid out 4 permanent linear increment plots in the Eastern and Western Kanara Divisions during April, 1939. These plots have now been in existence for over 13 years. Two quinquennial diameter remeasurements have been done in 1944 and 1949 and 99·5 % of the stems, 4 inches and over in d.b.h., have been indentified. This short note is an interim report on the information collected from these plots.

LOCATION OF THE PLOTS AND THE CLIMATE OF THE TRACT

2. Two of the increment plots are situated in Sirsi–Siddapur Range of Eastern Kanara Division at elevations of 1,900 and 2,000 feet above sea-level and represent the higher Ghat slope evergreen forest. The other two lie along the lower slopes of the Ghats in the Western Kanara Division between 470 and 900 feet and thus cover the lower slope evergreens. The tract as a whole being subjected to the full force of the South-West monsoon, enjoys a hot and humid climate. The average rainfall, received mostly from June to October, ranges between 150 to 200 inches and heavy mists and dewfall occur during the months of November to January. The locality is free from frosts. The forests are notorious for their unhealthy climate and malaria, and are infested with leeches till the end of October.

BRIEF DESCRIPTION OF THE PLOTS

3. As their name implies, the linear increment plots are long narrow strips. They have a uniform width of one chain, the length varying from 27·5 to 67 chains. The central line in each case was surveyed and marked on ground with the help of trenches and wooden posts, the positions of individual trees being determined in terms of offsets from this line. Records of all trees, down to the 4 inches over-bark d.b.h. limit, falling inside each plot, were thus prepared and their diameters callipered. The trees were classified into 3 canopy classes* – dominant, dominated and suppressed – and in the case of the two Western Kanara plots the size of the crown was also noted†. The plots have been remeasured at 5-year intervals in April, 1944 and April, 1949 when, besides callipering the numbered trees, their canopy and crown classes were re-assessed. The salient points about each plot are noted below :—

(i) *Plot No. 1, Eastern Kanara Division*—Length 60·5 chains. Situated at Kodkani in Sirsi–Siddapur Range. Altitude 2,000 feet, aspect varied; mean annual rainfall about 150 inches. Excepting for light tapping for canes by the villagers the locality carries a virgin forest. The plot at the time of its formation was not considered to be "quite representative of typical evergreen forest".

(ii) *Plot No. 2, Eastern Kanara Division*—Length 27·5 chains. Situated at Katlikan–Harlu in Sirsi–Siddapur Range. Altitude 1,900 feet; aspect North-West and South-West; mean annual rainfall about 200 inches. The plot lies in virgin forest and has been adjudged a "good specimen of evergreen forests and represents practically all the important evergreen species".

(iii) *Plot No. 1, Western Kanara Division*—Length 67 chains. Lies along the lower slope of the Malemane Ghat in Honawar Range. Altitude 470 feet: aspect North-West: mean annual rainfall 175 to 200 inches. According to records the plot "lies in Tropical Evergreen type with a sprinkling of deciduous species on the margins of gaps".

(iv) *Plot No. 2, Western Kanara Division*—Length 66 chains. Situated at Devimane in Kumta Range. Altitude about 900 feet: aspect North-West and mean annual rainfall 150 inches. The plot is located in virgin forest that is considered to be a good representative of the evergreen forest in the locality.

* The use of the terms dominant, dominated and suppressed in the case of the multi-stroeyed uneven-aged forest is not strictly in keeping with the standard terminology. They are, however, advisedly retained in the case of Indian increment plot practice because the amount of direct sunlight received by a tree is of real significance from the point of view of its rate of growth.

† The three crown size classes adopted are (1) big, (2) medium and (3) small.

COMPOSITION OF THE TREE FLORA

4. The Forest Botanist, Forest Research Institute, collaborated in the work of identification of the numbered tree stems. Dr. N. L. Bor, then Forest Botanist, visited the plots at the time of their formation and specimens were occasionally received from the local authorities after that. The task of identification has proved to be an arduous one due to the inaccessibility of the crowns in most cases and the difficulty in obtaining complete specimens. However, out of a total of 4,002 trees in the 4 plots, only 21 trees remain unidentified.

5. A detailed list of trees standing in each plot, by 4-inch diameter and three canopy classes is given as an Appendix. This illustrates the richness of the local tree flora and gives an objective and quantitative picture of its composition as a whole, as well as by different diameter and canopy classes. As the plots all lie in virgin tropical evergreen forest, and as at least two of these are considered to be typical specimens of the evergreen forests of the locality, this picture may be regarded as representative of the type, although, on account of obvious deficiencies, it cannot form a sound basis for management purposes over any large forest area. The following statement, based on the above list, brings out a few interesting details.

STATEMENT 1.—*A few interesting points about the composition of the Tropical Evergreen Forests in the Kanaras*

Serial No.	Description of item	E.D. Kanara L.T.I. Plot		W.D. Kanara L.T.I. Plot		All plots taken together
		No. 1 (Area = 5·6 acres)	No. 2 (Area = 2·7 acres)	No. 1 (Area = 6·7 acres)	No. 2 (Area = 6·6 acres)	
1	Total number of stems, 4″ and over in diameter, present at the time of formation	1064	377	1179	1382	4002
2	Number of stems completely identified	1054	374	1172	1368	3968
3	Number of stems partially identified	1	2	5	5	13
4	Number of unidentified stems ..	9	1	2	9	21
5	Total number of species to which the identified stems belong ..	76	54	68	73	130
6	Contribution of individual species expressed as percentage of the total number of stems ..	0·1 to 12·2%	0·3 to 17·2%	0·1 to 17·9%	0·1 to 17·4%	..
7	Number of genera represented ..	66	44	60	59	96
8	Contribution of individual genera expressed as percentage of the total number of stems ..	0·1 to 12·2%	0·3 to 17·2%	0·1 to 17·9%	0·1 to 17·4%	..
9	Number of families to which the above species belong ..	32	26	30	28	..
10	Contribution of individual families expressed as percentage of the total number of stems ..	0·1 to 18·6%	0·3 to 23·1%	0·1 to 23·1%	0·1 to 25·1%	..
11	Number of dominant stems ..	392	135	185	188	..
12	Number of species into which the dominant stems fall ..	60	28	35	41	..
13	Contribution of individual species expressed as percentage of the total number of dominant stems	0·1 to 16·8%	0·1 to 25·9%	0·1 to 13·5%	0·1 to 8·5%	..

6. The enumerated and identified stems in the 4 plots belong to 130 different species. The number of species represented in individual plots varies from 56 to 76, and their proportion from 0·1 to 17·9 per cent. These species belong to as many as 96 genera, the maximum and minimum number of genera occurring in a plot being 66 and 44 respectively. The number of natural orders represented varies from 26 to 32. The contribution of even the most frequent natural order is only 25·1%. Taking the dominant trees alone into consideration it may be seen that as many as 28 to 60 species may contribute to the top canopy, the share of the commonest species being no more than 25·9%.

7. Some species like *Aglaia roxburghiana, Diospyros candolleana, Garcinia gambogia, Hopea wightiana, Knema attenuata, Nephelium longana* and *Olea dioica* appear to be of frequent occurrence all over the tract while species such as *Canthium didymum, Cinnamomum zeylanicum, Ficus nervosa, Holigarna arnottiana, Lansium anamalayanum, Machilus macrantha, Mallotus philippinensis, Myristica beddomei* and *Strombosia ceylanica* though not so common are also to be met in all parts. Others like *Vitex altissima, Sageraea laurifolia, Myristica malabarica, Diospyros oocarpa* and *Diospyros microphylla* are typical of the lower elevations whereas those like *Litsaea floribunda, Lophopetalum wightianum* and *Symplocos beddomei* may be found on the upper slopes only.

8. A close study of the records also indicates that the various species differ widely in their habits regarding the choice of site and occurrence as isolated trees or fair sized groups. Thus, *Bischofia javanica* is present in only one of the plots and all its 30 enumerated stems stand in an area of 0·15 acre. *Dipterocarpus indicus* also shows a similar tendency by occurring in only one of the plots in the form of isolated fair sized groups. *Pterospermum reticulatum,* although occurring in both the upper and lower slope forests, also exhibits a strong tendency to occur in selected parts. *Sideroxylon tomentosum*, *Hopea wightiana, Lansium anamalayanum, Myristica beddomei, Diospyros oocarpa* and *Calophyllum elatum* too, appear to occur in small isolated groups. As opposed to this *Aglaia roxburghiana, Knema attenuata, Nephelium longana, Diospyros candolleana, Garcinia cambogia, Polyalthia fragrans, Machilus macrantha, Cryptocarya wightiana, Sageraea laurifolia, Syzygium gardneri, Holigarna grahamii* and *Lophopetalum wightianum* are scattered all over the area in the form of single trees or very small groups. The above remarks based on data from narrow strips may be regarded as tentative and would have to be corroborated by more extensive field observations, which will also throw useful light on the actual ecological requirements of the individual species.

9. As the plots lie in virgin forests which are in an obvious state of equilibrium they give a cross section of balanced uneven-aged tree crops and can be utilized for estimating the proportion in which the various diameter classes are present in the tropical evergreen forest under natural conditions. In 1898, the French forester, de Liocourt, showed that the number of trees in successive diameter classes of a balanced uneven-aged diameter distribution represents a geometric series. In other words the quotient 'q' between the number of trees in successive diameter classes is constant. The subject has been studied by other workers subsequently mainly for the forests of the temperate regions. It has been shown that all such balanced diameter distributions are described by an exponential function of the form :

$$Y = k.e.^{-aX} \quad di$$

where Y stands for the number of trees in the diameter interval di, X stands for diameter at breast height, k and a are constants which characterize the stand structure, and e (= 2·718) is the base of the Napierian logarithms.

10. The above relationship can be reduced to the straight line form by taking logarithms and this fact is utilized to determine whether a certain uneven-aged distribution conforms to the law of de Liocourt. The constant 'a' gives the slope of the above straight line, while 'k'

indicates the relative density of the crop, higher or lower values of 'k' for a given value of 'a' signifying higher or lower density. The test has been applied to the data from the four plots. Species which do not normally grow beyond the bush or small tree stage, and therefore, do not contribute to the uppermost strata, have been excluded and the remaining stems classified into 4-inch diameter classes. The per acre figures for the four individual plots, as well as

STATEMENT 2.—*Showing the composition of crop in each plot by 4" diameter classes after excluding the species which do not normally go beyond the bush and the small tree stages*

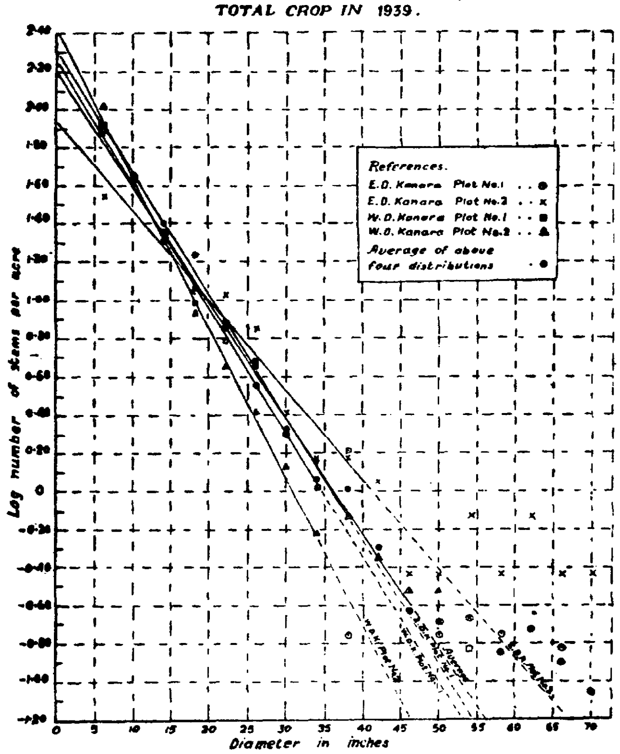
Name of plot	Per acre number of stems in diameter class (in inches)																	
	4–7	8–11	12–15	16–19	20–23	24–27	28–31	32–35	36–39	40–43	44–47	48–51	52–55	56–59	60–63	64–67	68–71	136–139
E.D. Kanara Plot No. 1	80·36	43·57	25·18	16·79	7·50	3·57	2·14	1·43	·18	..	..	·18	..	·18	..	..	..	..
E.D. Kanara Plot No. 2	34·44	38·52	20·00	11·11	10·37	7·04	2·59	1·48	1·48	1·11	·37	·37	·74	·37	·74	·37	·37	..
W.D. Kanara Plot No. 1	81·23	41·14	22·22	9·46	6·16	4·80	2·10	1·05	1·65	·45	·30	..	·15	..	..	·15	..	1·15
W.D. Kanara Plot No. 2	102·55	45·95	21·32	8·26	4·50	2·55	1·35	·60	·75	·45	·30	·30	..	..	..	..	..	..
Average	74·65	42·30	22·18	11·41	7·13	4·49	2·05	1·14	1·02	0·05	0·24	0·21	·22	·14	·19	·13	·09	·04

NOTE :—The diameters have been rounded off to the nearest inch. Thus 8 inches is anything between 7·5 to 8·4 inches and the class 8 to 11 inches extends from 7·5 to 11·4 inches.

those for the diameter distribution represented by the average of all the four, are given in Statement 2. The data have been plotted in Graph I and straight lines fitted in each case.

Graph I

LOG NUMBER OF STEMS PER ACRE/DIAMETER
TOTAL CROP IN 1939.



11. It may be seen that, barring the few trees (about 1·5% of the total stock) in the uppermost diameter classes, a straight line gives the best fit for all these distributions. The fit is remarkably good for the two W.D. Kanara plots and E.D. Kanara L.I. Plot No. 1 whereas the data from E.D. Kanara L.I. Plot No. 2 show considerable scatter. The values of 'a', 'k' and 'q' for the four plots as well as for the stand represented by their averages are given in Statement 3.

STATEMENT 3.—*The values of 'a', 'k' and 'q' for the 4 plots and for the distribution represented by their averages*

Plot No.	'a'	'k'	'q'
E.D. Kanara plot No. 1	0·107	50	1·81
E.D. Kanara plot No. 2	0·078	22	1·54
W.D. Kanara plot No. 1	0·180	45	1·82
W.D. Kanara plot No. 2	0·130	67	2·06
Average distribution	0·101	40	1·75

12. It is apparent that the law of de Liocourt applies to the virgin tropical evergreen forests in the Kanaras and can, therefore, be utilized for determining how far a certain uneven-aged diameter distribution in the locality differs from the ideal of the balanced stand and the intensity and pattern of thinnings required to produce the latter. Moreover, a balanced distribution can have many patterns. In other words, the proportion of stems in one diameter class to those in other and the density of the crop may fluctuate within considerable limits. Detailed research work would be necessary to determine the optimum distribution pattern for each set of conditions.

MORTALITY OR DRAIN UNDER NATURAL CONDITIONS

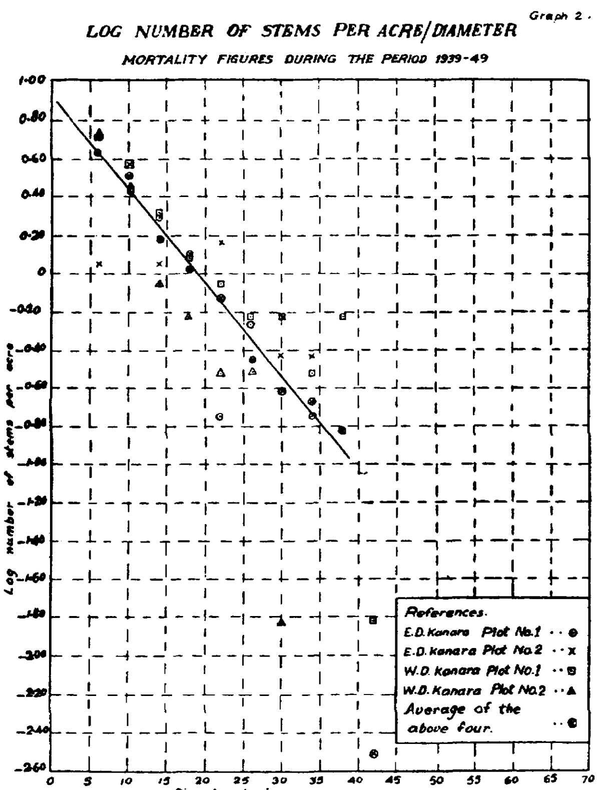
13. An accurate record of the trees which have died in the plots during this period of ten years is available from the plot files. This information is summarized in Statement 4 below :

STATEMENT 4.—*Mortality per acre during the period 1939–1949 after excluding the species which do not normally go beyond the bush and the small tree stage*

Diameter class (inches)	E.D. Kanara Plot No. 1	E.D. Kanara Plot No. 2	W.D. Kanara Plot No. 1	W.D. Kanara Plot No. 2	Average of all four
4– 7	5·178	1·111	5·105	5·555	4·237
8–11	2·678	3·703	3·753	2·852	3·246
12–15	1·964	1·111	2·102	·900	1·519
16–19	1·250	1·111	1·201	·600	1·040
20–23	·178	1·481	·900	·300	·714
24–27	·535	..	·600	·300	·358
28–31	..	·370	·600	·015	·246
32–35	·178	·370	·300	..	·212
36–39	..	..	·600	..	·150
40–43	..	..	·015	..	·003

14. It has already been mentioned (*vide* para 3 *supra*) that the plots were laid out in virgin forest. As no fellings have been made and no unusual incidence of fungal or insect diseases noticed during this period, the above figures give an idea of normal mortality or drain which may be expected in the evergreen forests of the tract under natural conditions. The average values, being based on the total area under observation, may be taken as more dependable than those for individual plots. As in forests which are in a state of equilibrium normal drain equals normal increment, the above mortality figures can also serve as a guide for fixing the gross yield from the virgin and other fully stocked and balanced tropical evergreen forests of the locality. This will be a somewhat conservative estimate because with the introduction of scientific management the over-mature, moribund, diseased and other such classes of trees are replaced by healthier and vigorously growing ones, thereby enhancing the increment of the forest as a whole.

15. The mortality data have been examined to see if the law of de Liocourt is applicable in their case as well. In Graph 2 logarithms of numbers of stems in each 4-inch diameter class have been plotted against corresponding mid-diameter values. It is clear that the



straight line would give the best fit in each case. The fit is quite close in the case of E.D. Kanara plot No. 1, W.D. Kanara plots No. 1 and 2 and the average figures. As in the case of the data for the total crop, the points for E.D. Kanara plot No. 2 show considerable scatter. There is thus a close parallelism between the total crop and the mortality rate data from this plot. This may be partly due to the smallness of its area which is less than half of any of the remaining three. A straight line has been fitted to the points representing the average values. The value of 'q' in this case works out as 1·57.

RATE OF GROWTH OF INDIVIDUAL SPECIES

16. One of the chief objects of laying out these plots was to determine the rate of diameter growth of the different species in the locality. The measurement of diameters of the same trees at regular intervals makes the realization of that object possible. Since all the trees were allotted their canopy classes and in the case of the W.D. Kanara plots the crowns also were classified according to their sizes, it will be possible in due course to determine the growth rates of individual species by localities and the various canopy or crown classes if necessary. For such a detailed analysis a much larger number of measurements will be required than are available at present.

17. The data have been examined from the point of view of determining the over-all rates of growth of the maximum number of species at this stage. The number of measurements available in the case of practically all species for individual plots being very small, the data from the 4 plots have been pooled together. This step is justified because the plots lie in the same type of forest growing under more or less identical climatic conditions. Analysis has been attempted for 19 species with a minimum of 50 stems each. Average values of 5-yearly diameter increment were calculated for each 2-inch d.b.h., class and plotted on section paper against diameter. From these smooth curves were obtained giving the relationship between b.h. diameter and its 5-yearly increment in each case. Starting at the lowest diameter value and reading the 5-yearly increments at successive steps the curves were next converted into growth curves. As these tropical overgreen species do not develop annual growth rings it has not been possible to determine the time taken to reach the 4 inches d.b.h. stage and thereby shift the origins of the diameter growth curves to the germination stage. The second set of curves has been utilized to prepare the following two statements which give, for each species, the growth of diameter in terms of time and number of years taken by them to pass through the various 2-inch diameter classes.

STATEMENT 5.—*Rate of diameter growth for the various species*

Age counting from the 4 inches d.b.h. Stage	DIAMETER AT BREAST HEIGHT																	
	Aglaia roxburghiana	*Diospyros candolleana*	*Diospyros oocarpa*	*Dipterocarpus* indicus*	*Garciana cambogia*	*Holigarna grahamii*	*Hopea wightiana*	*Ixora brachiata*	*Knema attenuata*	*Lansium anamalayanum*	*Myristica beddomei*	*Myristica malabarica*	*Nephelium longana*	*Nothopegia dalzellii*	*Olea dioica*	*Polyalthia fragrans*	*Pterospermum reticulatum*	*Sageraea laurifolia*	*Syzygium gardneri*
10	4·6	4·3	4·4	7·7	4·3	5·0	4·7	4·3	4·6	4·4	4·5	4·6	4·7	4·4	4·6	5·0	5·0	4·5	4·7
20	5·3	4·7	4·9	8·4	4·7	6·0	5·5	4·7	5·2	4·9	5·1	5·3	5·4	4·8	5·1	6·3	6·0	5·0	5·4
30	6·1	5·0	5·5	9·2	5·2	7·1	6·4	5·1	5·8	5·4	5·7	6·0	6·3	5·3	5·8	8·1	7·0	5·6	6·2
40	6·9	5·4	6·1	10·0	5·7	8·2	7·3	5·5	6·4	6·0	6·3	6·8	7·1	5·8	6·5	10·2	8·1	6·2	7·2
50	7·8	5·9	6·8	10·8	6·3	9·3	8·2	5·9	7·1	6·7	7·0	7·5	8·0	6·4	7·3	12·4	9·1	6·8	8·2
60	8·7	6·3	7·6	11·8	6·9	10·4	9·3	6·3	7·7	7·4	7·6	8·3	9·0	7·1	8·2	14·7	10·1	7·4	9·4
70	9·6	6·8	8·3	12·7	7·6	11·6	10·4	6·7	8·4	8·2	8·3	9·2	10·1	7·8	9·1	17·0	11·2	8·1	10·8
80	10·6	7·4	9·0	13·7	8·4	12·7	11·5	7·1	9·1	9·1	9·1	10·0	11·3	8·6	10·1	19·2	12·3	8·8	12·2
90	11·6	8·0	9·8	14·7	9·3	13·9	12·8	7·5	9·8	10·0	9·8	10·9	12·6	9·5	11·1	21·3	13·4	9·5	13·8
100	12·6	8·6	10·6	15·7	10·3	15·2	14·0	7·9	10·5	10·9	10·6	11·7	13·9	..	12·3	23·4	14·5	10·3	15·6
110	13·6	9·3	11·4	16·7	11·3	16·5	15·4	8·3	11·3	11·9	11·3	12·6	15·4	..	13·6	..	15·6	11·1	17·6
120	14·7	10·1	12·2	17·7	12·4	17·8	16·8	8·7	12·0	12·9	12·1	13·5	17·0	..	15·0	..	16·7	11·9	19·6
130	15·8	10·9	13·0	18·8	13·6	19·1	18·3	9·1	12·8	13·9	12·9	14·4	18·8	..	16·5	..	17·8	12·8	21·8
140	17·0	11·8	13·7	19·8	14·9	20·4	19·7	9·6	13·6	..	13·7	15·3	20·6	..	18·1	..	18·9	13·7	24·1
150	18·1	12·8	14·5	20·9	16·2	21·8	21·2	10·0	14·4	..	14·5	16·2	22·6	..	19·8	..	20·0	14·7	26·5
160	19·4	13·8	15·3	22·0	17·6	23·2	22·7	10·4	15·2	..	15·3	17·1	..	..	21·6	..	21·2	15·7	28·9
170	20·6	14·9	16·1	23·2	19·0	..	..	..	16·1	..	16·1	18·0	..	..	23·5	..	..	16·7	..
180	..	16·2	17·0	24·4	..	..	..	..	17·0	..	16·9	18·9	..	..	..	..	..	..	..
190	..	17·5	17·8	25·6	..	..	..	..	17·9	..	17·7	19·8	..	..	..	..	..	..	..
200	..	..	18·5	26·8	..	..	..	..	18·8	..	18·5	..	..	..	..	..	..	..	..
210	..	..	19·3	28·0	..	..	..	..	19·7	..	19·3	..	..	..	..	..	..	..	..
220	..	..	..	..	..	..	..	..	20·7	..	20·1	..	..	..	..	..	..	..	..

* The age in this case has been counted from 7" d.b.h. stage.

STATEMENT 6.—*Time taken by the various species to cross different diameter classes*

Diameter (b.h.) Class	No. of years required to Cross the Diameter Class																	
	Aglaia roxburghiana	*Diospyros candolleana*	*Diospyros oocarpa*	*Dipterocarpus indicus*	*Garciana cambogia*	*Holigarna grahamii*	*Hopea wightiana*	*Ixora brachiata*	*Knema attenuata*	*Lansium anamalayanum*	*Myristica beddomei*	*Myristica malabarica*	*Nephelium longana*	*Nothopegia dalzellii*	*Olea dioica*	*Polyalthia fragrans*	*Pterospermum reticulatum*	*Sageraea laurifolia*	*Syzygium gardneri*
4″– 6″	29	53	38	..	46	20	26	53	33	40	36	29	27	43	33	18	20	37	27
6″– 8″	23	38	28	..	29	18	22	50	31	27	29	27	23	29	25	11	19	32	21
8″–10″	22	28	26	25	22	18	19	47	29	23	27	24	19	24	21	10	20	27	16
10″–12″	21	23	26	22	19	18	17	..	27	21	27	23	17	..	18	9	18	25	15
12″–14″	19	20	25	21	17	17	16	..	25	20	25	22	14	..	16	9	19	22	12
14″–16″	18	17	25	20	16	16	14	..	24	..	25	22	14	..	13	9	18	20	11
16″–18″	17	14	25	20	14	15	14	..	23	..	25	23	12	..	13	9	18	..	10
18″–20″	16	..	..	19	..	15	14	..	21	..	25	22	11	..	12	9	18	..	10
20″–22″	..	..	..	18	..	14	13	..	..	..	..	..	10	..	11	9	17	..	9
22″–24″	..	..	..	17	..	15	14	..	..	..	..	..	..	..	10	10	..	..	9
24″–26″	..	..	..	17	..	..	..	..	..	..	..	..	..	..	..	..	..	..	8
26″–28″	..	..	..	16	..	..	..	..	..	..	..	..	..	..	..	..	..	..	8

ACKNOWLEDGEMENTS

The author expresses his deep gratitude to Shri C. R. Ranganathan, I.F.S., President Forest Research Institute and Colleges and Shri V. S. Krishnaswamy, I.F.S., Central Silviculturist, for their sympathetic guidance in the work and very valuable suggestions at different stages. The computational part was mostly done by Shri Prem Nath and Shri M. K. Lala, Computors, under the able supervision of Shri B. M. Bhattacharya, Lower Assistant.

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APPENDIX.—*Detailed list of trees standing in the four Linear Increment Plots—E.D. Kanara*

Serial No.	Species	Family	Crown class	L.I. Plot No. 1, Kanara Eastern Division								
				7" and below	8"–11"	12"–15"	16"–19"	20"–23"	24" and above	Total		%
1	*Actinodaphne hirsuta*	*Lauraceæ*	D	1	..	..	..	..	..	1		
			d	1	..	..	..	..	..	1	2	0·2
			s	..	..	..	..	..	..	..		
2	*Adenochlaena indica*	*Euphorbiaceae* ..	D	..	..	..	..	..	..	..		
			d	..	..	..	..	..	..	..	..	..
			s	..	..	..	..	..	..	..		
3	*Aglaia roxburghiana* (Syn. *A. odoratissima*)	*Meliaceae*	D	3	15	13	13	4	1	49		
			d	19	10	3	2	1	..	35	123	11·6
			s	36	2	1	..	..	..	39		
4	*Agrostistachys meeboldii*	*Euphorbiaceae* ..	D	..	..	..	..	..	..	..		
			d	..	..	..	..	..	..	..	..	..
			s	..	..	..	..	..	..	..		
5	*Ailanthus malabarica*	*Simarubaceae* ..	D	..	..	..	..	..	..	..		
			d	..	..	..	..	..	..	..	..	..
			s	..	..	..	..	..	..	..		
6	*Alphonsea lutea*	*Anonaceae*	D	..	..	..	1	..	..	1		
			d	..	..	..	..	..	..	..	1	0·1
			s	..	..	..	..	..	..	..		
7	*Alseodaphne semicarpifolia*	*Lauraceae*	D	..	..	..	..	..	..	..		
			d	..	..	..	..	..	..	..	..	..
			s	..	..	..	..	..	..	..		
8	*Alstonia scholaris*	*Apocynaceae*	D	..	..	..	..	..	1	1		
			d	..	..	..	..	..	..	..	1	0·1
			s	..	..	..	..	..	..	..		
9	*Amoora canarana*	*Meliaceae*	D	..	..	..	..	..	..	..		
			d	..	..	..	..	..	..	..	..	..
			s	..	..	..	..	..	..	..		
10	*Amoora rohituka*	*Meliaceae*	D	1	1	..	..	..	..	2		
			d	1	..	..	..	..	..	1	4	0·4
			s	1	..	..	..	..	..	1		
11	*Antiaris toxicaria*	*Moraceae*	D	..	..	..	..	..	..	..		
			d	..	..	..	..	..	..	..	..	..
			s	..	..	..	..	..	..	..		
12	*Antidesma menasu*	*Euphorbiaceae* ..	D	..	..	..	..	..	..	..		
			d	..	..	..	..	..	..	..	2	0·2
			s	2	..	..	..	..	..	2		
13	*Artocarpus hirsuta*	*Moraceae*	D	..	..	..	..	1	..	1		
			d	1	..	..	..	..	..	1	4	0·4
			s	2	..	..	..	..	..	2		
14	*Artocarpus lakoocha*	*Moraceae*	D	..	..	..	..	..	..	..		
			d	..	1	..	..	..	..	1	1	0·1
			s	..	..	..	..	..	..	..		
15	*Atalantia monophylla*	*Rutaceae*	D	..	..	..	..	..	..	..		
			d	..	..	..	..	..	..	..	..	..
			s	..	..	..	..	..	..	..		
16	*Atalantia racemosa*	*Rutaceae*	D	..	..	..	..	..	..	..		
			d	..	..	..	..	..	..	..	1	0·1
			s	1	..	..	..	..	..	1		
17	*Beilschmiedia bourdilloni*	*Lauraceae*	D	..	1	1	..	..	..	2		
			d	1	..	..	..	..	1	2	5	0·5
			s	..	1		..	..	..	1		
18	*Bischofia javanica*	*Euphorbiaceae* ..	D	..	1	3	4	5	3	16		
			d	..	7	2	..	..	..	9	30	2·8
			s	2	1	2	..	..	..	5		
19	*Blachia denudata*	*Euphorbiaceae*	D	..	..	..	..	..	..	..		
			d	..	..	..	..	..	..	..	..	
			s	..	..	..	..	..	..	..		

Nos. 1 and 2 and W.D. Kanara Nos. 1 and 2—by 4" diameter and 3 canopy classes

L.I. Plot No. 2, Kanara Eastern Division									L.I. Plot No. 1, Kanara Western Division									L.I. Plot No. 2, Kanara Western Division								
7" and below	8"–11"	12"–15"	16"–19"	20"–23"	24" and above	Total		%	7" and below	8"–11"	12"–15"	16"–19"	20"–23"	24" and above	Total		%	7" and below	8"–11"	12"–15"	16"–19"	20"–23"	24" and above	Total		%
.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..	 4	.. 1 ..	.. 1 ..	.. .. ..	.. .. ..	.. .. ..	.. 2 4	6	0·4
.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..	 1	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	 1	1	0·1	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..
.. .. 1	 1	.. .. ..	.. .. ..	1	.. .. ..	1 .. 2	3	0·8	.. 1 11	.. 7 2	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. 8 13	21	1·8	.. 3 13	4 6 3	1 3 ..	.. .. ..	1	1	7 12 16	35	2·5
.. 1 3	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. 1 3	4	1·1	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..		..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..
.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..	 1	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	 1	1	0·1	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..
.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..
.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..	.. 1 ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. 1 ..	1	0·1
.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..	.. .. ..	 1	.. .. ..	.. .. ..	.. .. ..	1	1 .. 1	2	0·2	.. .. ..	.. 2 ..	2 1 ..	1	1	.. .. ..	4 3 ..	7	0·5
.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..	.. 1 ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	1	1 1 ..	2	0·1
.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..
.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..	 1	.. 1 ..	.. 1 ..	2	.. .. ..	1	3 2 1	6	0·5	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..
.. .. 1	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	 1	1	0·3	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..
.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..	 1	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	 1	1	0·1	 1	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	 1	1	0·1
.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..	.. .. ..	.. .. ..	.. 1 ..	.. .. ..	.. .. ..	.. .. ..	.. 1	1	0·1
.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..		..	 2	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	 2	2	0·2	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..
.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..
.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..	.. .. ..	.. .. ..	1 1 ..	2	.. .. ..	.. .. ..	3 1 ..	4	0·3	.. 1 2	.. 1 ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. 2 2	4	0·3
.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. ..	.. ..
.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..	 1	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	 1	1	0·1	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..

(*contd.*)

APPENDIX.—*Detailed list of trees standing in the four Linear Increment Plots—E.D. Kanara*

Serial No.	Species	Family	Crown class	L.I. Plot No. 1, Kanara Eastern Division								
				7" and below	8"–11"	12"–15"	16"–19"	20"–23"	24" and above	Total		%
20	*Callicarpa lanata*	*Verbenaceae*	D	..	..	..	..		..	..		
			d	1	..	..	..	..	..	1	3	0·3
			s	2	..	..	..	..	..	2		
21	*Calophyllum elatum*	*Guttiferae*	D	..	..	..	..	..	..	..		
			d	..	..	..	..	..	..	..	..	..
			s	..	..	..	..	..	..	..		
22	*Canarium strictum*	*Burseraceae*	D	..	1	1	..	..	..	2		
			d	1	..	..	..	..	..	1	3	0·3
			s	..	..	..	..	..	..	..		
23	*Canthium didymum*	*Rubiaceae*	D	..	1	..	..	..	..	1		
			d	..	..	..	..	..	..	..	3	0·3
			s	2	..	..	..	..	..	2		
24	*Carallia integerrima*	*Rhizophoraceae* ..	D	..	..	1	..	..	..	1		
			d	..	..	..	..	..	..	..	1	0·1
			s	..	..	..	..	..	..	..		
25	*Careya arborea*	*Myrtaceae*	D	..	1	..	..	..	..	1		
			d	..	..	..	..	..	..	..	1	0·1
			s	..	..	..	..	..	..	..		
26	*Caryota urens*	*Palmae*	D	..	..	..	..	..	..	..		
			d	..	..	..	..	..	..	..	..	..
			s	..	..	..	..	..		..		
27	*Casearia esculenta*	*Samydaceae*	D	2	..	2	..	..	..	4		
			d	4	..	..	..	..	..	4	17	1·6
			s	8	..	1	..	..	..	9		
28	*Casearia rubescens*	*Samydaceae*	D	..	..	..	..	..	..	..		
			d	..	..	..	..	..	..	..	..	..
			s	..	..	..	..	..	..	..		
29	*Casearia* sp.	*Samydaceae*	D	..	..	..	..	..	..	..		
			d	..	..	..	..	..	..	..	..	..
			s	..	..	..	..	..	..	..		
30	*Cassia fistula*	*Leguminosae*	D	..	..	..	..	..	..	..		
			d	1	..	..	..	..	..	1	1	0·1
			s	..	..	..	..	..	..	..		
31	*Celtis cinnamomea*	*Ulmaceae*	D	..	..	1	..	..	..	1		
			d	..	..	..	..	..	..	..	2	0·2
			s	1	..	..	..	..	..	1		
32	*Chrysophyllum roxburghii*	*Sapotaceae*	D	..	..	1	..	2	1	4		
			d	..	..	..	..	..	..	..	4	0·4
			s	..	..	..	..	..	..	..		
33	*Cinnamomum zeylanicum*	*Lauraceae*	D	..	..	1	..	1	..	2		
			d	3	2	..	..	..	..	5	10	0·9
			s	3	..	..	..	..	..	3		
34	*Clausena indica*	*Rutaceae*	D	..	..	..	..	..	..	..		
			d	..	..	..	..	..	..	..	..	..
			s	..	..	..	..	..	..	..		
35	*Clausena willdenowii*	*Rutaceae*	D	..	..	..	..	..	..	..		
			d	1	1	..	..	..	..	2	3	0·3
			s	1	..	..	..	..	..	1		
36	*Cleidion javanicum*	*Euphorbiaceae* ..	D	..	..	..	..	..	..	..		
			d	..	..	..	..	..	..	..	..	..
			s	..	..	..	..	..	..	..		
37	*Cryptocarya bourdilloni*	*Lauraceae*	D	..	..	..	..	..	..	..		
			d	..	..	..	..	..	..	..	..	..
			s	..	..	..	..	..	..	..		
38	*Cryptocarya wightiana*	*Lauraceae*	D	4	3	11	2	..	1	21		
			d	4	4	1	..	..	..	9	35	3·3
			s	4	1	..	..	..	..	5		

Nos. 1 and 2 and W.D. Kanara Nos. 1 and 2—by 4" diameter and 3 canopy classes

L.I. Plot No. 2, Kanara Eastern Division									L.I. Plot No. 1, Kanara Western Division									L.I. Plot No. 2, Kanara Western Division								
7" and below	8"–11"	12"–15"	16"–19"	20"–23"	24" and above	Total		%	7" and below	8"–11"	12"–15"	16"–19"	20"–23"	24" and above	Total		%	7" and below	8"–11"	12"–15"	16"–19"	20"–23"	24" and above	Total		%
.. .. 1	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	 1	1	0·3	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..
.. .. ..	1	1	.. .. ..	.. 1 ..	4	6 1 ..	7	1·9	 2	.. 5 2	.. .. ..	.. .. ..	1	.. .. ..	1 5 4	10	0·8	 9	.. 4 ..	5 1 ..	2 1 ..	1	4	12 6 9	27	2·0
.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..	.. .. ..	.. .. ..	.. 1 ..	.. .. ..	.. .. ..	.. .. ..	.. 1 ..	1	0·1
.. .. 1	 1	.. .. ..	.. .. ..	.. .. ..	.. .. ..	 2	2	0·5	 3	 1	.. 1 ..	.. .. ..	.. .. ..	.. .. ..	.. 1 4	5	0·4	 1	.. .. ..	1	.. .. ..	.. .. ..	.. .. ..	1 .. 1	2	0·1
.. .. ..	.. .. ..	.. .. ..	1	.. .. ..	.. .. ..	1	1	0·3	.. .. ..	.. 1 ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. 1 ..	1	0·4	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..
.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..
.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..	.. 3 9	2 10 ..	.. 1 ..	.. .. ..	.. .. ..	.. .. ..	2 14 9	25	1·8
.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..
.. .. 1	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	 1	1	0·3	 2	 3	1 2 ..	.. .. ..	.. .. ..	.. .. ..	1 2 5	8	0·7	.. 3 9	1 5 ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	1 8 9	18	1·3
.. .. 1	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	 1	1	0·3	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..
.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..	.. .. ..	.. .. ..	.. 1 ..	.. .. ..	.. .. ..	.. .. ..	.. 1 ..	1	0·1
.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	2	2	2	0·2	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..
.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..	.. .. ..	.. .. ..	.. .. ..	.. 1 ..	1	.. .. ..	1 1 ..	2	0·1
.. .. 2	1	.. .. ..	.. .. ..	.. .. ..	1	2 .. 2	4	1·1	 5	.. 1 2	.. 1 ..	1	.. .. ..	.. .. ..	1 2 7	10	0·8	 5	2 1 1	2	3	1	.. .. ..	8 1 6	15	1·1
.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..	 6	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	 6	6	0·5	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..
.. .. 1	 1	.. .. ..	.. .. ..	.. .. ..	.. .. ..	 2	2	0·5	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..	.. .. ..	.. 1 ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. 1 ..	1	0·1
.. .. ..	.. 1 ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. 1 ..	1	0·3	.. .. ..	.. 1 ..	.. 1 ..	.. .. ..	.. .. ..	.. .. ..	.. 2 ..	2	0·2	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..
.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..	 10	.. 4 1	1	.. .. ..	1	1	3 4 11	18	1·5	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..
.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..

(contd.)

APPENDIX.—*Detailed list of trees standing in the four Linear Increment Plots—E.D. Kanara*

Serial No.	Species	Family	Crown class	L.I. Plot No. 1, Kanara Eastern Division								
				7" and below	8"–11"	12"–15"	16"–19"	20"–23"	24" and above	Total		%
39	*Cyclostemon confertiflorus*	*Euphorbiaceae* ..	D d s	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..
40	*Dimorphocalyx lawianus*	*Euphorbiaceae* ..	D d s	 2	.. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	 2	2	0·2
41	*Diospyros assimilis*	*Ebenaceae*	D d s	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..
42	*Diospyros candolleana*	*Ebenaceae*	D d s	6 23 25	2 4 3	2	.. .. ..	.. .. ..	.. .. ..	10 27 28	65	6·1
43	*Diospyros microphylla*	*Ebenaceae*	D d s	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..
44	*Diospyros montana*	*Ebenaceae*	D d s	.. 1 2	3 1 ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	3 2 2	7	0·7
45	*Diospyros oocarpa*	*Ebenaceae*	D d s	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..
46	*Diospyros paniculata*	*Ebenaceae*	D d s	.. 2 5	 1	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. 2 6	8	0·8
47	*Diospyros pruriens*	*Ebenaceae*	D d s	.. 2 ..	.. .. ..	.. .. ..	1	..	.. .. ..	1 2 ..	3	0·3
48	*Dipterocarpus indicus*	*Dipterocarpaceae* ..	D d s	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..
49	*Dysoxylum malabaricum*	*Meliaceae*	D d s	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	3	3	3	0·3
50	*Elaeocarpus serratus*	*Tiliaceae*	D d s	1	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	1 ..	1	0·1
51	*Elaeocarpus tuberculatus*	*Tiliaceae*	D d s	.. 1 ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. 1 ..	1	0·1
52	*Ervatamia heyneana* (Syn. *Tabernaemotana heyneana*)	*Apocynaceae*	D d s	.. 1 2	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. 1 2	3	0·3
53	*Eugenia jambolana* (Syn. *Syzygium jambolanum*)	*Myrtaceae*	D d s	.. .. ..	.. .. ..	1 1 ..	2 1 ..	.. .. ..	.. .. ..	3 2 ..	5	0·5
54	*Eugenia macrosepala*	*Myrtaceae*	D d s	.. .. .	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..
55	*Eugenia* sp.	*Myrtaceae*	D d s	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..
56	*Ficus hispida*	*Moraceae*	D d s	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..
57	*Ficus nervosa*	*Moraceae*	D d s	 2	.. .. ..	.. .. ..	1 1 ..	.. .. ..	.. .. ..	1 1 2	4	0·4

Nos 1 and 2 and W.D. Kanara Nos. 1 and 2—by 4″ diameter and 3 canopy classes

L.I. Plot No. 2, Kanara Eastern Division

7″ and below	8″–11″	12″–15″	16″–19″	20″–23″	24″ and above	Total		%
.. 1 ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. 1 ..	1	0·3
.. .. 2	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	 2	2	0·5
.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..
.. 2 1	.. 3 ..	1	.. .. ..	.. .. ..	.. .. ..	1 5 1	7	1·9
.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..
.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..
.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..
.. 1 1	.. 1 ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. 2 1	3	0·8
.. .. 1	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	 1	1	0·3
.. 1 ..	3 4 6	5 3 ..	7	9	11	35 8 6	49	13·0
.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..
.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..
.. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	1	1	1	0·3
.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..
.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..
1 .. 5	.. 1 ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	1 1 5	7	1·9
.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..
.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..
.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	2	2	2	0·5

L.I. Plot No. 1, Kanara Western Division

7″ and below	8″–11″	12″–15″	16″–19″	20″–23″	24″ and above	Total		%
.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..
.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..
.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..
.. 2 14	.. 6 ..	6 1 1	4	.. .. ..	1	11 9 15	35	3·0
.. 2 4	.. 3 ..	2	3 1 ..	4	3	12 6 4	22	1·9
.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..
.. 14 79	4 52 16	13 24 1	5 3 ..	.. .. ..	.. .. ..	22 93 96	211	17·9
.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..
.. .. 3	.. 1 ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. 1 3	4	0·3
.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..
.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	1	1	1	0·1
.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. ..	..	..
.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..		..
.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..
.. .. ..	.. .. ..	.. .. ..	1 1 ..	.. .. ..	4	5 1 ..	6	0·5
.. .. 5	 1	.. .. ..	.. .. ..	.. .. ..	.. .. ..	 6	6	0·5
.. .. 2	.. 1 ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. 1 2	3	0·3
.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..
.. .. 2	 1	.. .. ..	1	.. .. ..	3	4 .. 3	7	0·6

L.I. Plot No. 2, Kanara Western Division

7″ and below	8″–11″	12″–15″	16″–19″	20″–23″	24″ and above	Total		%
.. .. 2	.. .. ..	.. .. ..	.. .. ..	1	.. .. ..	1 .. 2	3	0·2
.. .. 1	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	1	0·1
.. 1 8	1 2 1	1 1 ..	1	.. 2 ..	.. .. ..	3 6 9	18	1·3
.. 4 17	.. 6 1	.. 2 ..	1	.. .. ..	.. .. ..	1 12 18	31	2·2
.. .. 2	.. 1 ..	.. .. ..	.. .. ..	1	.. .. ..	1 1 2	4	0·3
.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..
.. 8 54	3 11 4	3 6 1	5 2 ..	.. .. ..	.. .. ..	11 27 59	97	7·0
.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..
.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..
.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..
.. 1 ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. 1 ..	1	0·1
.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..
.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..
.. .. 2	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	 2	2	0·1
.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..
.. 2 11	.. 1 1	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. 3 12	15	1·1
.. .. ..	.. 1 ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. 1 ..	1	0·1
.. .. 2	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	 2	2	0·1
.. 1 1	1 2 ..	.. 1 ..	.. .. ..	.. .. ..	.. .. ..	1 4 1	6	0·4

(contd.)

APPENDIX.—*Detailed list of trees standing in the four Linear Increment Plots—E.D. Kanara*

Serial No	Species	Family	Crown class	L.I. Plot No. 1, Kanara Eastern Division								
				7" and below	8"–11"	12"–15"	16"–19"	20"–23"	24" and above	Total		%
58	*Ficus* sp.	*Moraceae*	D	..	..	..	..	..	..	..		
			d	..	..	..	1	..	..	1	1	0·1
			s	..	..	..	..	..	..	..		
59	*Flacourtia montana*	*Bixaceae*	D	2	5	1	..	..	..	8		
			d	8	4	..	..	..	..	12	27	2·5
			s	6	1	..	..	..	..	7		
60	*Garcinia cambogia*	*Guttiferae*	D	2	3	5	5	1	..	16		
			d	9	4	1	..	..	..	14	42	3·9
			s	10	2	..	..	..	..	12		
61	*Garcinia malabarica*	*Guttiferae*	D	..	..	..	..	..	..	..		
			d	..	..	..	..	..	..	..	..	..
			s	..	..	..	..	..	..	..		
62	*Garcinia morella*	*Guttiferae*	D	1	..	..	..	..	..	1		
			d	1	..	..	..	..	..	1	7	0·7
			s	4	1	..	..	..	..	5		
63	*Glochidion fagifolium*	*Euphorbiaceae*	D	..	..	..	..	..	..	..		
			d	..	2	..	..	..	..	2	5	0·5
			s	2	1	..	..	..	..	3		
64	*Gymnacranthera canarica*	*Myristicaceae*	D	..	..	..	..	..	..	..		
			d	..	..	..	..	..	..	..	..	..
			s	..	..	..	..	..	..	..		
65	*Harpullia imbricata* (Syn. *H. cupanioides*)	*Sapindaceae*	D	..	2	..	..	..	..	2		
			d	..	..	..	..	..	..	..	4	0·4
			s	..	2	..	..	..	..	2		
66	*Heynea trijuga*	*Meliaceae*	D	..	..	..	..	..	..	..		
			d	1	..	1	..	..	..	2	2	0·2
			s	..	..	..	..	..	..	..		
67	*Holigarna* sp.	*Anacardiaceae*	D	..	..	..	..	..	..	..		
			d	..	..	..	..	..	..	..	..	..
			s	..	..	..	..	..	..	..		
68	*Holigarna arnottiana*	*Anacardiaceae*	D	..	..	..	2	..	..	2		
			d	..	..	..	..	..	..	..	2	0·2
			s	..		..	..	..	..	..		
69	*Holigarna grahamii*	*Anacardiaceae*	D	2	1	2	..	2	..	7		
			d	2	3	..	..		..	5	16	1·5
			s	4	..	..	..	..	..	4		
70	*Hopea wightiana*	*Dipterocarpaceae*	D	..	1	..	1	..	..	2		
			d	1	..	..	..	..	..	1	5	0·5
			s	2	..	..	..	..	..	2		
71	*Hydnocarpus laurifolia*	*Bixaceae*	D	..	..	..	..	..	3	3		
			d	..	..	..	1	..	..	1	4	0·4
			s		..	..	..		..	..		
72	*Hymenodictyon obovatum*	*Rubiaceae*	D	..	..	..	..	..	..	..		
			d		..	..	..	..	..	..	..	..
			s	..	..	..	..	..	..	..		
73	*Ixora barachiata*	*Rubiaceae*	D	..	1	..	..	..	..	1		
			d	..		..	..	..	..	..	9	0·8
			s	8	..	..	..	..	..	8		
74	*Ixora nigricans*	*Rubiaceae*	D	..	..	..	..	..	..	..		
			d	..	..	..	..		..	..	..	
			s	..	..	..	..	..	..	..		
75	*Jambosa laeta*	*Myrtaceae*	D	..	..	1	..	..	..	1		
			d	1	..	..	..	..	..	1	7	0·7
			s	4	1	..	..	..	..	5		
76	*Knema attenuata*	*Myristicaceae*	D	1	4	4	3	1	1	14		
			d	5	6	3	..	..	..	14	45	4·2
			s	9	4	3	1	..	..	17		

Nos. 1 and 2 and W.D. Kanara Nos. 1 and 2—by 4" diameter and 3 canopy classes

L.I. Plot No. 2, Kanara Eastern Division									L.I. Plot No. 1, Kanara Western Division									L.I. Plot No. 2, Kanara Western Division								
7" and below	8"–11"	12"–15"	16"–19"	20"–23"	24" and above	Total		%	7" and below	8"–11"	12"–15"	16"–19"	20"–23"	24" and above	Total		%	7" and below	8"–11"	12"–15"	16"–19"	20"–23"	24" and above	Total		%
.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	1	1	1	0·1
.. .. ..	1	.. .. ..	.. .. ..	.. .. ..	.. .. ..	1	1	0·3	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..	 3	 1	.. 1 ..	.. .. ..	.. .. ..	.. .. ..	.. 1 4	5	0·4
.. .. 1	 2	 1	1	.. .. ..	.. .. ..	1 .. 4	5	1·3	.. 1 6	.. 2 1	1	2	.. .. ..	.. .. ..	3 3 7	13	1·1	.. 8 25	1 9 ..	4 3 ..	2 1 ..	1 .. 1	.. .. ..	8 21 26	55	4·0
.. .. ..	.. .. ..	.. 1 ..	.. .. ..	.. .. ..	.. .. ..	.. 1 ..	1	0·3	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..
.. .. 1	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	 1	1	0·3	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..	.. 1 30	.. 1 1	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. 2 31	33	2·4
.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..
.. 1 3	1 2 2	 2	2 1 ..	.. .. ..	.. .. ..	3 4 7	14	3·7	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..
.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..
.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..	.. .. ..	2 1 ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	2 1 ..	3	0·2
.. .. 1	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	 1	1	0·3	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..	.. .. ..	 1	.. .. ..	.. .. ..	.. .. ..	.. .. ..	 1	1	0·1
.. .. ..	.. 1 2	2 2 ..	.. .. ..	.. .. ..	.. .. ..	2 3 2	7	1·9	 4	 1	.. .. ..	.. 1 ..	1	1	2 1 5	8	0·7	.. .. ..	.. .. ..	1 1 ..	2	.. .. ..	.. .. ..	3 1 ..	4	0·3
.. .. ..	.. 1 ..	1	2	1	1	5 1 ..	6	1·6	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..	.. 3 10	1 4 1	8 5 ..	3	.. .. ..	.. .. ..	12 12 11	35	2·5
.. 1 15	1 5 7	2 3 ..	.. 1 ..	3	.. .. ..	6 10 22	38	10·1	.. 3 58	1 28 19	7 24 1	8 6 ..	3 2 ..	2 1 ..	21 64 78	163	13·8	.. 8 42	3 9 5	1 3 ..	1	2	2 1 ..	9 21 47	77	5·6
.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..	 1	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	 1	1	0·1	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..
.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..	.. .. ..	.. .. ..	.. .. ..	1	.. .. ..	.. .. ..	1	1	0·1	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..
.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..	 16	 1	 1	.. .. ..	.. .. ..	.. .. ..	 18	18	1·5	 41	.. 2 2	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. 2 43	45	3·3
.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..	 1	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	 1	1	0·1
.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..	.. .. ..	 1	.. 1 ..	.. .. ..	 1	.. .. ..	.. 1 2	3	0·3	 4	.. .. ..	.. .. ..	1	.. .. ..	.. .. ..	1 .. 4	5	0·4
.. .. 1	 3	1	.. .. ..	.. .. ..	.. .. ..	1 .. 4	5	1·3	.. 2 51	.. 10 20	1 4 2	.. 2 ..	.. .. ..	.. .. ..	1 18 73	92	7·8	.. 9 143	.. 49 35	4 9 1	.. .. ..	.. .. ..	.. .. ..	4 67 170	241	17·4

(contd.)

APPENDIX.—*Detailed list of trees standing in the four Linear Increment Plots—E.D. Kanara*

Serial No.	Species	Family	Crown class	L.I. Plot No. 1, Kanara Eastern Division								
				7" and below	8"-11"	12"-15"	16"-19"	20"-23"	24" and above	Total		%
77	*Lagerstroemia flos-reginae*	*Lythraceae*	D	..	..	..	..	..	..	..		
			d	..	..	..	..	..	..	..	..	..
			s	..	..	..	..	..	..	..		
78	*Lagerstroemia lanceolata*	*Lythraceae*	D	1	3	6	4	4	8	26		
			d	..	1	..	..	..	..	1	29	2·7
			s	2	..	..	..	..	..	2		
79	*Lansium anamalayanum*	*Meliaceae*	D	1	..	..	..	..	2	3		
			d	6	9	2	..	..	..	17	65	6·1
			s	36	9	..	..	..	..	45		
80	*Lepisanthes* sp.	*Sapindaceae*	D	..	..	..	..	..	..	..		
			d	..	..	..	..	..	..	..	..	..
			s	..	..	..	..	..	..	..		
81	*Lepisanthes tetraphylla*	*Sapindaceae*	D	..	..	..	..	..	..	..		
			d	..	..	..	..	..	..	..	2	0·2
			s	2	..	..	..	..	..	2		
82	*Linociera malabarica*	*Oleaceae*	D	..	..	..	..	..	..	..		
			d	..	..	..	..	..	..	..	..	..
			s	..	..	..	..	..	..	..		
83	*Litsaea coriacea*	*Lauraceae*	D	..	..	..	..	..	..	..		
			d	..	..	..	..	..	..	..	..	..
			s	..	..	..	..	..	..	..		
84	*Litsaea floribunda*	*Lauraceae*	D	..	3	1	2	2	4	12		
			d	6	5	3	..	..	..	14	37	3·5
			s	6	2	3	..	..	..	11		
85	*Litsaea oleoides*	*Lauraceae*	D	..	..	1	..	..	..	1		
			d	..	..	..	..	..	..	..	1	0·1
			s	..	..	..	..	..	..	..		
86	*Litsaea stocksii*	*Lauraceae*	D	..	..	..	..	..	..	..		
			d	..	..	..	..	..	..	..	..	..
			s	..	..	..	..	..	..	..		
87	*Lophopetalum wightianum*	*Celastraceae*	D	..	..	..	..	..	1	1		
			d	..	..	..	..	..	..	..	1	0·1
			s	..	..	..	..	..	..	..		
88	*Macaranga roxburghii*	*Euphorbiaceae* ..	D	..	..	1	..	..	..	1		
			d	..	..	..	..	..	..	..	1	0·1
			s	..	..	..	..	..	..	..		
89	*Machilus macrantha*	*Lauraceae*	D	1	1	1	3	1	2	9		
			d	1	2	..	..	..	..	3	12	1·1
			s	..	..	..	..	..	..	..		
90	*Madhuca malabarica* (Syn. *Bassia malabarica*)	*Sapotaceae*	D	..	..	..	..	..	..	..		
			d	..	..	..	..	..	..	..	..	..
			s	..	..	..	..	..	..	..		
91	*Mallotus philippinensis*	*Euphorbiaceae* ..	D	3	3	2	..	..	..	8		
			d	..	..	..	..	..	..	..	12	1·1
			s	3	1	..	..	..	..	4		
92	*Mangifera indica*	*Anacardiaceae* ..	D	..	..	1	1	..	..	2		
			d	3	..	..	..	..	..	3	9	0·8
			s	3	1	..	..	..	..	4		
93	*Mastixia pentandra* (Syn. *Mastixia arborea*)	*Costnaceae*	D	..	..	..	..	..	1	1		
			d	1	1	..	..	..	..	2	3	0·3
			s	..	..	..	..	..	..	..		
94	*Memecylon edule*	*Melastomaceae* ..	D	..	..	..	..	..	..	..		
			d	..	..	..	..	..	..	..	..	..
			s	..	..	..	..	..	..	..		
95	*Memecylon* sp.	*Melastomaceae* ..	D	..	..	..	..	..	..	..		
			d	..	..	..	..	..	..	..	..	..
			s	..	..	..	..	..	..	..		

Nos. 1 and 2 and W.D. Kanara Nos. 1 and 2—by 4" diameter and 3 canopy classes

L.I. Plot No. 2, Kanara Eastern Division

7" and below	8"–11"	12"–15"	16"–19"	20"–23"	24" and above	Total		%
.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..
.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..
.. .. 1	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	 1	1	0·3
.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..
.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..
.. .. 1	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	 1	1	0·3
.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..
.. .. 2	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	 2	2	0·5
.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..
.. .. 2	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	 2	2	0·5
.. 1 ..	1 .. 1	3 1 1	2 1 ..	1	8	15 3 2	20	5·3
.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..
.. .. ..	.. .. ..	.. 1 ..	.. .. ..	2	6	8 1 ..	9	2·4
.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..
.. .. 3	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	 3	3	0·8
.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..
.. .. 1	.. 2 1	1	.. 2 1	.. .. ..	.. .. ..	1 4 3	8	2·1
.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..
.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..

L.I. Plot No. 1, Kanara Western Division

7" and below	8"–11"	12"–15"	16"–19"	20"–23"	24" and above	Total		%
.. .. ..	 1	.. 2 ..	1 2 ..	4 1 ..	6 2 ..	11 7 1	19	1·6
.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	2	2	2	0·2
.. 1 29	 1	.. 2 1	.. .. ..	.. .. ..	.. .. ..	.. 3 31	34	2·9
.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..
.. 1 1	.. 2 ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. 3 1	4	0·3
.. .. 1	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	 1	1	0·1
.. .. 1	.. .. ..	.. 1 ..	.. .. ..	.. .. ..	.. .. ..	.. 1 1	2	0·2
.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..
.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..
.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..
.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..
.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..
.. .. 1	 1	.. .. ..	.. .. ..	.. .. ..	.. .. ..	 2	2	0·2
.. .. 1	 5	.. .. ..	.. .. ..	.. .. ..	.. .. ..	 6	6	0·5
.. .. 1	 1	.. .. ..	.. .. ..	.. .. ..	.. .. ..	 2	2	0·2
.. .. 2	.. .. ..	1	.. .. ..	.. .. ..	.. .. ..	1 .. 2	3	0·3
.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..
.. .. 1	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	 1	1	0·1
.. .. 2	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	 2	2	0·2

L.I. Plot No. 2, Kanara Western Division

7" and below	8"–11"	12"–15"	16"–19"	20"–23"	24" and above	Total		%
.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..
.. .. ..	.. .. ..	.. 1 ..	.. .. ..	1	5	6 1 ..	7	0·5
.. 1 ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. 1 ..	1	0·1
.. .. 1	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	 1	1	0·1
.. .. 4	 1	.. .. ..	.. .. ..	.. .. ..	.. .. ..	 5	5	0·4
.. .. 4	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	 4	4	0·3
.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..
.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..
.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..
.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..
.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..
.. .. 4	 1	.. .. ..	.. .. ..	.. .. ..	.. .. ..	 5	5	0·4
.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	1 1 ..	1 1 ..	2	0·1
.. .. 6	.. 1 3	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. 1 9	10	0·7
.. .. 16	.. 1 1	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. 1 17	18	1·3
.. .. 4	.. .. ..	.. .. ..	2	.. .. ..	.. .. ..	2 .. 4	6	0·4
.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..
.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..
.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..

(*contd.*)

APPENDIX.—*Detailed list of trees standing in the four Linear Increment Plots—E.D. Kanara*

Serial No.	Species	Family	Crown class	L.I. Plot No. 1, Kanara Eastern Division								
				7" and below	8"–11"	12"–15"	16"–19"	20"–23"	24" and above	Total		%
96	*Mesua ferrea*	*Guttiferae*	D	..	..	..	..	..	..	..		
			d	..	..	..	..	..	..	..	..	..
			s	..	..	..	..	..	..	..		
97	*Mimusops elengi*	*Sapotaceae*	D	..	1	..	..	..	1	2		
			d	1	..	..	..	..	..	1	5	0·5
			s	2	..	..	..	..	..	2		
98	*Myristica beddomei*	*Myristicaceae*	D	1	..	1	1	2	1	6		
			d	..	4	1	1	1	..	7	17	1·6
			s	2	2	..	..	..	..	4		
99	*Myristica magnifica*	*Myristicaceae*	D	..	..	..	..	..	..	..		
			d	..	..	..	..	..	..	..	..	..
			s	..	..	..	..	..	..	..		
100	*Myristica malabarica*	*Myristicaceae*	D	..	..	..	..	..	..	..		
			d	..	..	..	..	..	..	..	..	..
			s	..	..	..	..	..	..	..		
101	*Neolitsaea foliosa var. caesia*	*Lauraceae*	D	..	..	..	..	..	..	..		
			d	1	..	..	..	..	..	1	4	0·4
			s	3	..	..	..	..	..	3		
102	*Nephelium longana*	*Sapindaceae*	D	5	4	1	5	3	1	19		
			d	1	2	3	1	..	..	7	58	5·5
			s	28	3	1	..	..	..	32		
103	*Nothopegia dalzellii*	*Anacardiaceae*	D	1	1	..	..	..	..	2		
			d	1	..	..	..	..	..	1	10	0·9
			s	6	1	..	..	..	..	7		
104	*Nothopegia* sp.	*Anacardiaceae*	D	..	..	..	..	..	..	..		
			d	..	..	..	..	..	..	..	..	..
			s	..	..	..	..	..	..	..		
105	*Ochrocarpus longifolius*	*Guttiferae*	D	..	..	..	..	..	..	..		
			d	..	..	..	..	..	..	..	..	..
			s	..	..	..	..	..	..	..		
106	*Olea dioica*	*Oleaceae*	D	5	16	17	18	7	3	66		
			d	17	12	5	1	2	..	37	130	12·2
			s	18	6	2	1	..	..	27		
107	*Palaquium ellipticum*	*Sapotaceae*	D	..	..	..	..	..	..	..		
			d	..	..	..	..	..	..	..	..	..
			s	..	..	..	..	..	..	..		
108	*Pithecolobium bigeminum*	*Leguminosae*	D	..	..	..	..	..	..	..		
			d	..	..	..	..	..	..	..	..	..
			s	..	..	..	..	..	..	..		
109	*Polyalthia fragrans*	*Anonaceae*	D	..	..	..	..	..	..	..		
			d	..	..	..	..	..	..	..	..	..
			s	..	..	..	..	..	..	..		
110	*Pterospermum reticulatum*	*Sterculiaceae*	D	3	9	9	4	1	..	26		
			d	2	1	1	1	..	..	5	38	3·6
			s	6	1	..	..	..	..	7		
111	*Pygeum wightianum*	*Rosaceae*	D	..	..	..	..	..	..	..		
			d	..	..	..	..	..	..	..	..	..
			s	..	..	..	..	..	..	..		
112	*Rapanea capitellata*	*Myrsinaceae*	D	..	..	..	..	..	..	..		
			d	1	..	..	..	..	..	1	2	0·2
			s	1	..	..	..	..	..	1		
113	*Sageraea laurifolia*	*Anonaceae*	D	..	..	..	..	..	..	..		
			d	..	..	..	..	..	..	..	..	..
			s	..	..	..	..	..	..	..		
114	*Saraca indica*	*Leguminosae*	D	..	..	..	..	..	..	..		
			d	..	..	..	..	..	..	..	..	..
			s	..	..	..	..	..	..	..		

Nos. 1 and 2 and W.D. Kanara Nos. 1 and 2—by 4″ diameter and 3 canopy classes

L.I. Plot No. 2, Kanara Eastern Division									L.I. Plot No. 1, Kanara Western Division									L.I. Plot No. 2, Kanara Western Division								
7″ and below	8″–11″	12″–15″	16″–19″	20″–23″	24″ and above	Total		%	7″ and below	8″–11″	12″–15″	16″–19″	20″–23″	24″ and above	Total		%	7″ and below	8″–11″	12″–15″	16″–19″	20″–23″	24″ and above	Total		%
1 .. 1	1 1 ..	.. 2 ..	.. .. ..	1 1 ..	.. .. ..	3 4 1	8	2·1	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..
.. .. ..	.. 1 ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. 1 ..	1	0·3	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..	 3	.. 1 1	.. .. ..	.. .. ..	1	.. .. ..	1 1 4	6	0·4
.. .. ..	 2	.. .. ..	.. 1 ..	.. .. ..	.. .. ..	.. 1 2	3	0·8	 1	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	 1	1	0·1	.. 4 41	1 5 11	1 1 ..	.. .. ..	.. .. ..	.. .. ..	2 10 52	64	4·6
.. .. ..	 1	.. 1 ..	1	1	.. .. ..	2 1 1	4	1·1	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..
.. .. ..	.. .. ..	.. .. ..	1	.. .. ..	.. .. ..	1	1	0·3	.. 1 21	1 4 7	1 4 ..	.. .. ..	.. .. ..	.. .. ..	2 9 28	39	3·3	 24	1 7 4	4 5 ..	.. 1 ..	.. .. ..	.. .. ..	5 13 28	46	3·3
.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..	 2	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	 2	2	0·1
.. 2 24	3 6 10	5 3 4	2 1 ..	3 1 ..	1	14 13 38	65	17·2	.. 2 35	.. 2 5	.. 2 2	.. .. ..	.. .. ..	.. .. ..	.. 6 42	48	4·1	.. 1 37	.. 19 6	.. 3 3	.. .. ..	.. .. ..	.. .. ..	.. 23 46	69	5·0
.. 1 3	.. 1 1	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. 2 4	6	1·6	.. 1 74	 1	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. 1 75	76	6·4	.. 1 22	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. 1 22	23	1·7
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.. .. ..	.. .. ..	.. .. ..	1	1	.. .. ..	2	2	0·5	 1	.. 2 ..	1 2 ..	3	2	1	7 4 1	12	1·0	.. 1 14	1 6 3	3 6 ..	2 3 ..	4	3	13 16 17	46	3·3
.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..	.. .. ..	.. .. ..	1	.. .. ..	.. .. ..	.. .. ..	1	1	0·1	.. 4 48	2 6 5	5 8 ..	4 3 1	3	2 1 ..	16 22 54	92	6·7
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.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..	.. 5 26	1 10 8	2 5 ..	.. 1 ..	.. .. ..	.. .. ..	3 21 34	58	4·9	 6	.. 5 1	1	.. 1 ..	.. .. ..	.. .. ..	1 6 7	14	1·0
.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..	 4	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	 4	4	0·3	 4	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	 4	4	0·3

(contd.)

APPENDIX.—*Detailed list of trees standing in the four Linear Increment Plots—E.D. Kanara*

Serial No.	Species	Family	Crown class	L.I. Plot No. 1, Kanara Eatsern Division: 7" and below	8"–11"	12"–15"	16"–19"	20"–23"	24" and above	Total		%
115	*Schleichera oleosa*	*Sapindaceae*	D d s	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..
116	*Semecarpus travancorica*	*Anacardiaceae* ..	D d s	.. .. ..	 1	.. .. ..	1	.. .. 	.. .. ..	1 .. 1	2	0·2
117	*Sideroxylon tomentosum*	*Sapotaceae*	D d s	2 3 8	3 1 3	1 2 ..	3 1 ..	.. .. ..	.. .. ..	9 7 11	27	2·5
118	*Sterculia guttata*	*Sterculiaceae*	D d s	.. .. ..	2	.. .. ..	1	.. .. ..	.. .. ..	3	3	0·3
119	*Stereospermum chelonoides*	*Bignoniaceae*	D d s	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..
120	*Strombosia ceylanica*	*Olacaceae*	D d s	1 3 ..	.. 1 1	.. .. ..	.. .. ..	.. .. ..	.. .. ..	1 4 1	6	0·6
121	*Symplocos beddomei*	*Styraceae*	D d s	4 2 3	5 7 2	6 1 ..	2 ..	.. .. ..	.. .. ..	17 10 5	32	3·0
122	*Syzygium gardneri*	*Myrtaceae*	D d s	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..
123	*Terminalia belarica*	*Combretaceae*	D d s	.. .. ..	.. .. ..	.. .. ..	.. .. ..	1	.. .. ..	1	1	0·1
124	*Terminalia paniculata*	*Combretaceae*	D d s	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..
125	*Terminalia tomentosa*	*Combretaceae*	D d s	.. .. ..	4	.. .. ..	1	.. .. ..	.. .. ..	5	5	0·5
126	*Trewia nudiflora*	*Euphorbiaceae* ..	D d s	.. .. ..	.. .. ..	1	.. .. ..	.. .. ..	.. .. ..	1	1	0·1
127	*Vepris bilocularis*	*Rutaceae*	D d s	.. 2 2	.. 1 ..	 1	.. .. ..	.. .. ..	1	1 3 3	7	0·7
128	*Vitex altissima*	*Verbenaceae*	D d s	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..
129	*Walsura piscidia*	*Meliaceae*	D d s	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..
130	*Webera corymbosa*	*Rubiaceae*	D d s	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	.. .. ..	..	..
131	Unidentified	..	D d s	.. 1 3	2 1 ..	.. .. ..	.. .. ..	.. .. ..	2	4 2 3	9	0·8
		TOTAL ..	D	54	103	100	81	38	41	417		39·2
			d	148	97	30	11	4	1	291		27·3
			s	286	54	14	2	0	0	356		33·5

Nos. 1 and 2 and W.D. Kanara Nos. 1 and 2—by 4" diameter and 3 canopy classes

L.I. Plot No. 2, Kanara Eastern Division									L.I. Plot No. 1, Kanara Western Division									L.I. Plot No. 2, Kanara Western Division								
7" and below	8"–11"	12"–15"	16"–19"	20"–23"	24" and above	Total		%	7" and below	8"–11"	12"–15"	16"–19"	20"–23"	24" and above	Total		%	7" and below	8"–11"	12"–15"	16"–19"	20"–23"	24" and above	Total		%
..	..	..	..	..	..	..			..	..	1	..	..	1	2			..	..	..	..	..	2	2		
..	..	..	..	..	..	..	..	..	..	..	2	2	..	..	4	6	0·5	..	..	..	..	..	..	..	2	0·1
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..	..	..	..	..	..	..	..	..	..	..	1	..	1	..	2	7	0·6	..	..	..	..	..	..	..	5	0·4
..	..	..	..	..	..	..			..	..	..	..	..	..	..			..	1	..	..	..	..	1		
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..	1	..	..	..	..	1	7	1·9	..	3	1	..	..	..	4	5	0·4	..	..	..	..	..	..	..	2	0·1
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..	..	..	..	..	..	..			..	..	1	1	..	1	3			..	..	..	1	..	..	1		
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1	..	..	..	..	..	1			..	..	..	..	..	..	..			5	..	..	..	..	..	5		
4	15	24	21	25	46		135	35·8	1	7	46	39	31	61		185	15·7	0	28	59	37	25	39		188	13·6
12	35	23	8	3	0		81	21·5	41	161	98	23	8	10		341	28·9	74	200	81	16	4	3		378	27·4
95	55	10	1	0	0		161	42·7	526	111	12	1	2	1		653	55·4	705	102	6	2	1	0		816	59·0

(concld.)

THE MOISTURE CONTENT OF SANDALWOOD

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Sandalwood (*Santalum album* Linn.) is one of the few woods which is handled on a basis of weight at every stage of its exploitation and processing from the standing tree to the ultimate consumer. It is common for the wood to be weighed correct to fractions of a pound ; and two-ounce pieces are popular counters in the retail sale of wood. The current handling practices of sandalwood (at any rate in Mysore) involve the storage of hundreds of tons of wood in godowns ("*Koti*") whose stocks are checked annually by the weighment of the entire stock. Also, sandalwood is used to fashion carvings of great beauty and delicacy and it is obviously necessary that these costly art pieces should be stable relative to their environmental moisture. For these reasons, the moisture content of Sandalwood is of considerable practical importance.

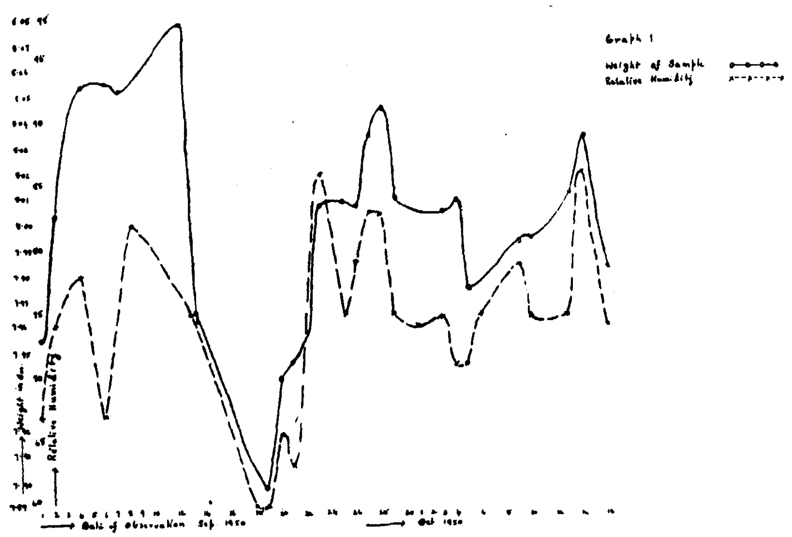
This paper records the variation in the moisture content of sandalwood under normal working conditions over a period of some six weeks. Usually, the bulk of the stock of a *Koti* consists of "roughwood" ; roughwood is the sandal tree "dressed" such that the piece consists of sandal heartwood covered with a layer of not more than about 1 inch of sapwood. The latter serves to ensure that there is no loss by pilferage of the valuable heartwood and, also, to some extent, to minimize the possible dissipation of the volatile constituents. Such "roughwood" is periodically issued for the preparation of the "goodwood" – that is pure heartwood in various sizes and shapes ranging from billets to *Chiltas* which are broken chips and on to "saw-dust". There is also present considerable quantities of mixed *Chiltas*, chips containing both the heart – and the sapwood of sandal, these varieties being the inevitable concomitant in the conversion of "roughwood" to "goodwood". Therefore, the moisture content of both the heartwood and sap-wood of sandal have significance in relation to normal *Koti* stocks.

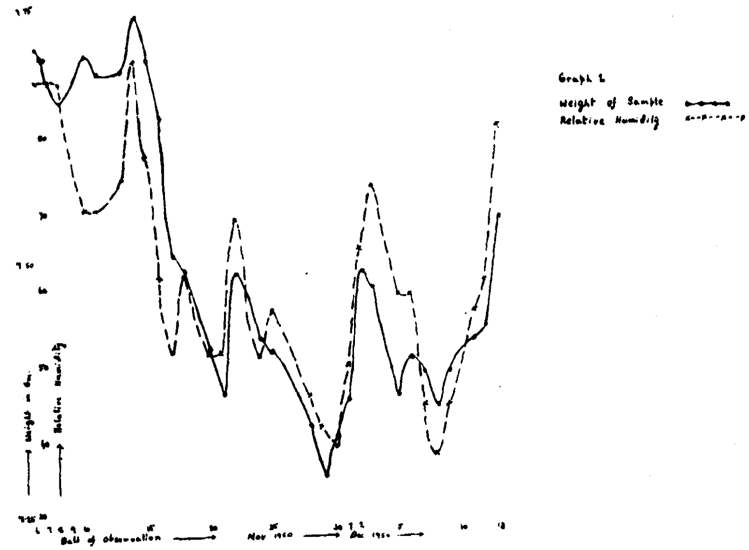
One of the authors during the course of stock-taking duties over a number of years weighed in all thousands of tons of wood at the Bangalore *Koti*. The roughwood at this *Koti* is stocked in a tiled-shed 130 feet by 112 feet with a height of 40 feet at the mid-centre beam. It always appeared to be cooler inside the shed than in a well-ventilated room in the immediate vicinity. The present occasion was made use of to verify this subjective feeling by factual records of temperature and relative humidity.

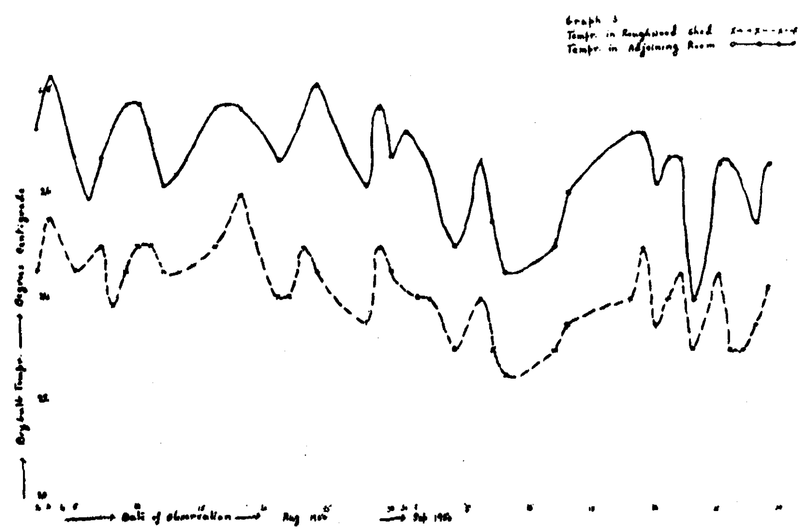
MATERIAL AND METHODS

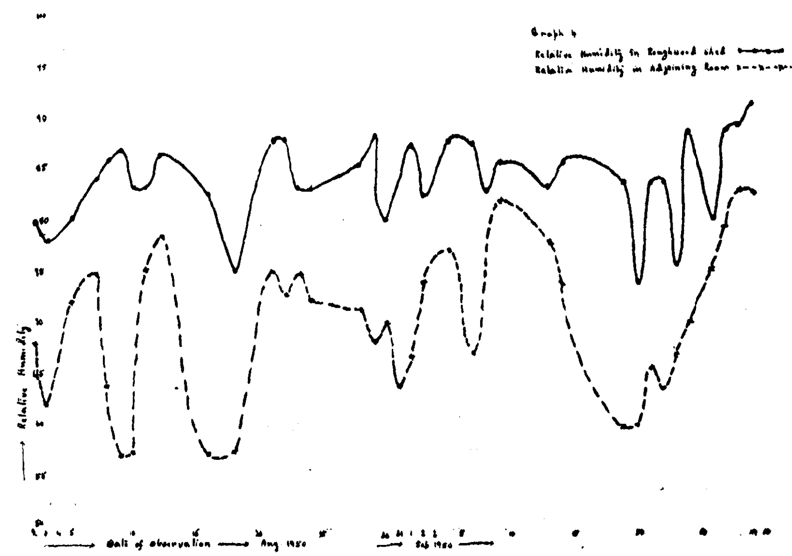
The heartwood for these experiments came from the goodwood stocks of the Bangalore *Koti*. The piece selected at random came from the smaller billet class – locally termed "*Ghatbadla*". The piece had been fashioned from the *Koti* roughwood 4 days prior to its selection. The piece was squared in the Laboratory, the surface chipped off and shavings made from out of the unexposed core of the piece. At every stage, clean, sharp steel tools were employed avoiding undue exposure and delay. The samples were immediately transferred to stoppered bottles and portions taken out for experimental work as and when necessary.

The sap-wood was taken from out of the roughwood stock selected at random from the *Koti*. None of the pieces came from material received during 1950–51 at the *Koti*. (It is not easy to ascertain the exact history of the pieces since they will be lying exposed in the fields for varying periods prior to being carted). Care was taken to discard layers exposed to the atmosphere as also contamination with heartwood.


Graph 1
Weight of Sample
Relative Humidity
Date of observation Sep 1950
Oct 1950


Graph 2
Weight of Sample
Relative Humidity
Date of observation
Nov 1950
Dec 1950


Graph 3
Tempr. in Roughwood shed
Tempr. in Adjoining Room
Degrees Centigrade
Date of observation
Aug 1950
Sep 1950


Graph 4
Relative Humidity in Roughwood shed
Relative Humidity in Adjoining Room
Relative Humidity
Date of observation
Aug 1950
Sep 1950

The choice of the experimental method of determination of moisture requires some care. Electrical conductivity methods were considered not accurate enough for the present work and were besides impracticable with shavings of wood. Oven-drying methods obviously introduce errors due to the loss of the volatile constituents present in the wood. The range of such errors for some Indian woods have been studied by Kapur and Narayanamurthy (1). Distillation with a volatile organic solvent of high boiling point and immiscible with water was a suitable and convenient method for our work. Xylene, saturated with water, was the solvent chosen (commercially pure grade, B.P. 138°C.). The apparatus was an all-glass Blender and Holbein unit which is a slight adapation of the one designed by Pritzker and Jungkunz (2). This is described and illustrated in the paper by Kapur and Narayanamurthy (loc. cit.).

Incidentally, the margin of error involved in estimating "moisture" in Sandalwood by the oven-drying method was also determined. The oven-drying was carried out in an Electrical oven at 105°C. with automatic temperature control with a margin of about 2°C. The oven-dried samples were cooled to room temperature in a desiccator over concentrated Sulphuric acid. In practice, "Constant weight" was never reached – the successive woights gradually petering away. At the end of about 53 hours of drying, the variations between successive weighings were of the order of 0·002 gm. in a sample weighing initially about 8–10 grams. The weight at the end of 53 hours of oven-drying was assumed to be "Constant weight".

The oil content of the wood was independently determined by refluxing with absolute alcohol in a Soxhlet, the shavings of wood being contained in a Swedish paper thimble. The refluxing was for 12 hours. The extracts (together with the washings of the residual wood and the apparatus) was evaporated in a tared glass basin over the water bath, the residual oil was heated in an oven at 105° for about 5–10 minutes, cooled in a desiccator over calcium chloride and weighed. The solvent extraction method is apt to give slightly higher figures than the yield by steam distillation. This does not, however, interfere with the objective of the present experiments.

The temperatures of the wet and dry bulb thermometers were recorded in the usual manner at 2 p.m. each day. On holidays, when the interior of the roughwood shed was inaccessible, no readings were taken. These points account for the breaks in the accompanying graphs.

RESULTS

A. The moisture and oil contents of the heartwood of sandal were as follows in two typical sets of experiments.

		I	II
		per cent	per cent
1.	"Moisture" by the oven-drying method ..	12·37	12·47
2.	"Moisture" by the Xylene distillation method ..	8·69	9·64
3.	"Oil content" by the Alcohol extraction of the undried wood ..	5·14	5·16
4.	"Oil content" by the Alcohol extraction of the over-dried wood ..	3·14	3·49

The results show that during the oven-drying of Sandalwood, in addition to moisture, nearly 3 per cent of the volatile constituents of the wood are also lost. The difference in the percentage of the oil content of the undried and the oven-dried wood is of the order of 2 per cent. The moisture content is, as usual, expressed with reference to the weight of the dry wood while the oil content is expressed merely as a percentage of the weight of the wood (whether dry or otherwise) from which it is extracted.

B. Variation in the weight of sandalwood in equilibrium with its environment.

The hundreds of weighings with about a dozen samples of wood over a period of six weeks are best summarized in the form of graphs in juxtaposition to curves showing the relative humidity during the period. Typical cases are illustrated here.

A. Graph 1 illustrates the behaviour of chips of heartwood of sandal exposed to the atmosphere. The cardinal points in the curve are :—

	gm.
Initial weight of chips	7·9515
Maximal weight recorded during the experiments	8·0810
Variation from initial weight	0·1305
Minimum weight recorded during the period	7·8915
Variation from initial weight	0·0600
Range of variation	0·1905

This range is 2·39 per cent of the initial weight of the chips. The daily variations run parallel to humidity changes.

B. Graph 2 records the fluctuations in the weights of chips of sap-wood of sandal exposed to the atmosphere.

	gm.
Initial weight of chips	7·7130
Maximal weight recorded during the period	7·7130
Variation from initial weight	nil
Minimum weight recorded during the period	7·2892
Variation from initial weight	0·4238
Range of variation	0·4238

This range is 5·37 per cent of the initial weight.

C. Graph 3 records the daily dry bulb temperatures inside the sandal roughwood shed and in a neighbouring well-ventilated room both at 2 p.m. Graph 4 records the relative humidity values in the two places also at 2 p.m. each day. Apart from the marked difference between the two sets of values, the graphs call for no comment.

CONCLUSION

The estimation of moisture in Sandalwood by the oven-drying method gives values which are about 3 per cent too high, due to the loss of the volatile constituents, in addition to the moisture, contained in the wood.

The weight of Sandalwood, especially in the form of chips, varies with the environmental moisture. For heartwood, the range of variation may be up to 2·39 per cent while for sap-wood, it may be as much as 5·37 per cent of the initial weight and over a period of six weeks.

The atmosphere in a shed stored with rough Sandalwood was found, for reasons which are to be enquired into, to be appreciably cooler and substantially more humid than in a room without the wood.

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A NOTE ON THE MINOR FOREST PRODUCTS OF CHAMBA (HIMACHAL PRADESH) AND SCOPE FOR THEIR DEVELOPMENT

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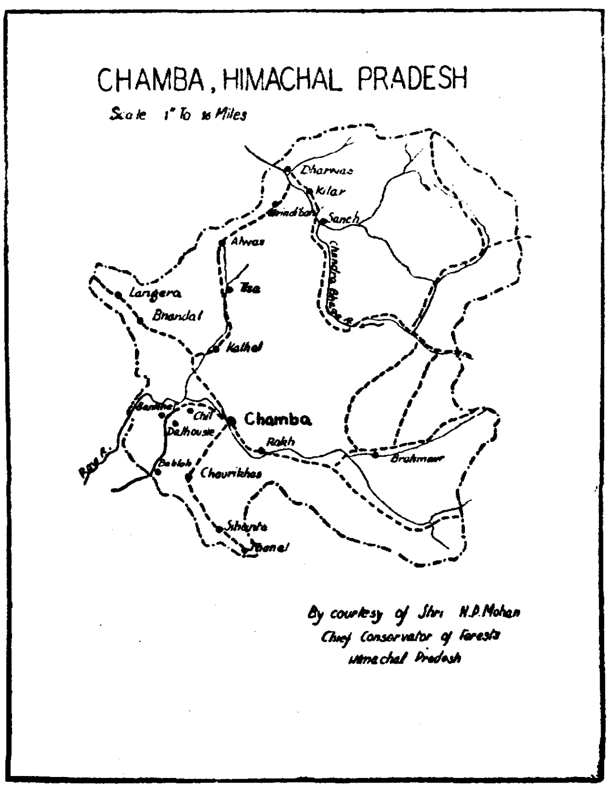
INTRODUCTION

Chamba State lies between 32° 10′ and 33° 13′ N. and 75° 3′ E. with an estimated area of 3,216 square miles. It is shut in on almost every side by lofty hill ranges. It is bounded on the West and North by the territories of Kashmir and on the East and South by the districts of Kangra and Gurdaspur. Two ranges of snow peaks run through the state ; one through the centre dividing the valley of Ravi and Chenab : the other along the borders of Ladakh and Lahoul. To the West and South stretch fertile valleys. The country is wholly mountainous and the principal rivers are the Chandra and Ravi which flow generally from South-East to North-West.



With an altitude of 2,000 to 21,000 feet a great variety of climate may be experienced, that of the lower tract resembles the plains except that heat in summer is less intense. In the central parts the heat in summer is great but the winter is mild and the snowfall light. On the higher ranges at altitudes from 5,000 to 20,000 feet the summer is mild and the winter severe with heavy snowfall. The autumn months are generally unhealthy except on the upper

ranges. The lower valleys are malarious, and in these the rains are heavy and prolonged. In the Ravi valley the rainy season is well marked and the rainfall considerable. In the Chenab valley it is scanty, heavy rain is unusual and the annual average does not exceed 10 inches. Rain also falls in the winter months and is important for both the spring and autumn crops, as on the higher ranges it is received as snow which melts in summer and supplies water for irrigation.

At the higher elevations the flora is the same as that of the North-West Himalayas generally, but some Kashmir types find their eastern limit in the western valleys. In the Ravi basin and Pangi, *Cedrus deodara* and other conifers abound and there are also considerable proportions of mixed forests. Chamba Lahoul has an almost purely Tibetan flora. The forests are alpine, few being below 5,000 feet elevation and large areas extend to 12,000 feet above the sea-level. Deodar and blue pine logs, sleepers and scantlings were exported from the forests on the rivers Ravi and Chenab to Lahore and Wazirabad.

MINOR FOREST PRODUCTS

Due to wide variation of altitudes the flora of Chamba presents a wide range of variation from tropical to the temperate and alpine types. A list of economic plants observed and collected is given below. Some of these are of known medicinal value and are recognized in the British Pharmacopœia and some others are used in the indigenous systems of medicine and can be exploited usefully by the 'Hakims' and 'Vaids'. There are few other plants which are utilized locally for some ailment or other, but are not recognized by any system of medicine.

List of the medicinal plants used in British Pharmacopœia, Indian Pharmacopœial list, Ayurvedic and Unani medicines which grow in Chamba district ; vernacular names are given in italics with brackets.

Acacia arabica (*Babul, Kikar*)
A. catechu (*Khair*)
Aconitum chasmanthum (*Mohri, Banbalnag*)
A. heterophyllum (*Patis*)
Artemisia vulgaris (*Seski*)
Atropa acuminata (*Jala kafal*)
Anglica glauca (*Chora*)
Adhatoda vasica (*Basuti*)
Acorus calamus (*Bach*)
Argemone mexicana (*Kandiari*)
Asparagus racemosus (*Mossli*)
Berberis aristata (*Rasunt*)
Betula utilis (*Bhojpatra*)
Cannabis sativa (*Bhang*)
Carum carvi (*Zira*)
Cassia fistula (*Amaltas*)
Cinnamomum tamala (*Tejpatra*)
Dryopteris odontoloma (Male-fern, *Kunji*)
Datura tatula (*Dhatura*)
Holarrhena antidysenterica (*Kurchi*)
Juniperus recurva (*Padam bij*)
Jurinea macrocephala (*Dhup*)
Melia indica (*Neem*)
Picrohhiza kurrooa (*Kour*)
Punica granatum (*Anar*)
Podophyllum emodi (*Bankakri*)
Papaver somniferum (*Post afiun*)
Rheum emodi (Rhubarb, *Rewand chini*)
Ricinis communis (*Arand,* Castor oil seed plant)
Rosa moschata (*Gulab*)
Saliva moorcroftiana (*Thuth*)
Saussurea lappa (*Kuth*)
Swertia chirata (*Chirata*)
Terminalia chebula (*Harar*)
T. belerica (*Bahera*)
Tinospora cordifolia (*Gilo*)
Taraxacum officinale (Dandelion, *Handmool*)
Thymus serphyllum (*Banajwain*)
Valarian wallichii (*Smak, Mushakbala*)
Viscum album (Mistletoe, *Al.*)
Viola odorata (*Banafsha*)
Withania somnifera (*Asgandh*)

The plants listed above grow in abundance in a state of nature but only few of them given below are extracted and marketed by the local dealers.

Aconitum chasmanthus
A. heterophyllum
Berberis aristata
Betula utilis
Juninea macrocephala
Picrorhiza liurrooa
Salvia moorcroftiana
Saussurea lappa

Roots of Kuth (*Sassurea lappa*) are cultivated and exploited by the Forest Department. In Lahoul the inhabitants take to Kuth-farming and sell it in Kulu and Kangra districts. The other medicinal plants listed above are not exploited on a commercial scale.

QUALITATIVE ANALYSIS OF THE DRUGS

A number of drug plants collected from Chamba have been analysed to compare the percentage of their active principles with the standards laid down in the British Pharmacopœia. From the perusal of the data it would appear that the drugs compare very favourably with these standards.

With a little modification in the methods of curing and storing the quality of drugs may be improved.

	Active principles present	B.P. Standard
Atropa acuminata (leaves)	0·35 per cent total alkaloids	0·3 per cent
Atropa acuminata (roots)	0·68 per cent total alkaloids	0·4 per cent
Datura tatula (leaves)	0·22 per cent total alkaloids	0·25 to 0·55 per cent
Datura alba (leaves)	0·16 per cent total alkaloids	
Podophyllum emodi (roots)	8·2 per cent resins	Not less than 8 per cent
Dryopteris blanfordi (male-fern) Rhizomes	3·5 to 4·1 per cent of filicin	Not less than 1·5 per cent
Carum carvi (seeds)	3·7 per cent essential oil	Not less than 3·5 per cent
Valerian wallichii (Rhizomes)	1·2 per cent essential oil	..
Saussurea lappa (roots)	1·3 per cent essential oil	..

ANNUAL OUTPUT OF DRUGS

There are no statistics maintained by the Forest Department regarding the annual yield of the drugs and other minor forest products, the reason being that the Forest Department never exercised any control over the exploitation of medicinal plants. Those who extracted the drugs sold them in the market in Chamba or outside without the knowledge of the Forest Department.

Enquiries were, however, made from certain dealers in this trade and rough estimates of the annual output of drugs are given below :—

	mds.
Jurinea macrocephala (*Dhup*)	700 to 1,000
Aconitum heterophyllum (*Patis*)	7 to 10
Picrorhiza kurrooa (*Kour*)	300 to 500
Valerian wallichii (*Mushakbala*)	200 to 400
Podophyllum emodi (*Bankakri*)	400 to 500
Salvia moorcroftiana (*Tuth*)	700 to 1,000
Saussurea lappa (*Kuth*)	500 to 1,000

Besides these, Viola, bark of walnut, caraway and artemisia are also extracted, but their figures could not be confirmed.

THE PRESENT POSITION OF MINOR FOREST PRODUCTS

It has been pointed out that till recently the Forest Department did not exercise any control over the extraction of minor forest products in the State. Anybody who had the access in the forest could extract any drug in any quantity which could be easily marketed. As a result of ruthless extraction without any attempt to artificial cultivation the drugs are becoming extinct. During the war the sale prices of minor forest products were very high ; more ruthless exploitation was done by the local people during this period in order to make profits.

Recently the Forest Department has restricted the excessive exploitation by an enactment under which only licensed individuals can extract and sell medicinal plants. Inspite of this the position is not much changed. The revenue accruing from royalty obtained from minor forest products has been almost negligible amounting to few thousands rupees. Except for the sale of *Saussurea lappa* (Kuth) which the Forest Department has cultivated, no other revenue accrues from this source to the State.

NEED FOR SYSTEMATIC EXPLOITATION AND CULTIVATION OF DRUG PLANTS

From the tours undertaken into the interior of Chamba it would appear that the drug resources of this area can be developed and handsome revenue can accrue from this source. This is possible in two ways :

(*a*) By planning systematic exploitation of drugs growing in abundance in the area.

(*b*) By undertaking systematic cultivation of some important drug plants.

As noted elsewhere only few of the drug plants are exploited and that also in a very unscientific and uneconomic manner. To exploit these and other medicinal plants properly, it would be essential to plan so that a steady annual yield of drugs growing in a state of nature is obtained. The Forest Department in consultation with an expert staff should so chalk out a plan as to give resting time for two to three years to all the areas in rotation. This would allow the plants time for natural regeneration and growth to maturity before harvesting the crop. Arrangements should be made for chemical analysis of drugs annually to determine the percentage of active principles. If these are high, higher prices will be obtained in the market. If there is deterioration of active principles due to curing and storing this should be improved.

All drugs should be got collected at the proper time when the active principles are at their maximum. For instance, the leaves should be collected just at flowering time, roots in autumn, flowers in bloom and seeds when mature. All these should be well dried before storing and marketing.

The collections should be botanically pure and mixtures with spurious products should be strictly prohibited. Adultrants can be sorted out while drying is being effected in the godowns. Crude drugs, should be up to the standards laid down in the pharmacopœias and codex to obtain a steady market. The exploitation of Minor Forest Products by unauthorized persons should be banned by an enactment and only the Government should exploit the minor forest products through approved contractors in a systematic way.

For undertaking a systematic cultivation such plants may be selected which have a ready market. Drugs such as *Belladonna*, *Hyoscyamus*, *Digitalis*, *Pyrethrum*, *Colchicum*, *Aconite*, *Lavetra*, *Podophyllum*, *Picrorhiza*, etc., can be cultivated at different suitable localities in forests under the expert supervision. Forest blanks and pastures of considerable dimensions are available in most of the places. Before extending the cultivation in new localities it would be advisable to concentrate at such places where already these plants grow in nature. These drugs have a ready market and bring promising revenue.

For successful cultivation and exploitation of drugs and experimental cultivation of exotics which can be successfully introduced, well-equipped chemical, pharmacological and botanical laboratories manned by experts are essential so that only the proper species are cultivated and the results of cultivation are verified side by side. At every stage of the growth of plants their active principles should be determined by chemical and biological methods of assay so that it is known how the cultivation is progressing. If the active principles do not come up to the required standard steps could be taken to improve their quality by proper manuring and other means advised by experts. Along with this, methods of drying and curing of the drugs for use in pharmaceutical industry suitable for the climatic and other conditions prevailing in the country should be worked out.

The Government of Jammu and Kashmir while recognizing the importance of the rich resources of its crude drugs referred the matter to experts and established the Drug Research Laboratory, staffed with Pharmacologists, Botanists and Chemists and fully equipped with all necessary apparatus and appliances. It is essential to maintain a close liaison between the Laboratories and the Forest Department if the development is to be affected on sound scientific lines. That is the only way in which it is likely to be successful and compete with other countries.

MARKETING OF MINOR FOREST PRODUCTS

It would be in the best interests of the Government to take the development and marketing of the raw materials under its own control and carry it out on proper lines. The price of the drugs produced should be in keeping with prevalent world price of crude drugs. In India during the war a good deal of black marketing in crude drugs took place and adulteration was rife. This has brought a very bad name to the Indian raw material in drugs and reliable firms of drug manufacturers look at Indian raw drugs with suspicion. To retrieve this unfortunate position much careful work will have to be done in the cultivation and marketing of drugs.

In the following table a list of common drugs which can be grown in Himachal Pradesh is given with their present prevalent prices in the Indian market. The market prices are subject to fluctuations in the London market and attempts to reduce the cost of production would always ensure a steady sale. If the prices are stablised at the lower side the Indian

pharmaceutical industry would rise to the occasion to manufacture standard preparations at reasonably low price so that these are within the easy reach of poor masses.

No.	Botanical Name	Popular Name	Part of Plant	Rate per maund
				Rs.
1	*Atropa acuminata*	Belladonna	Roots	184
2	*Atropa acuminata*	Belladonna	Leaves	202
3	*Aconitum heterophyllum*	*Pattis*	Roots	400
4	*A. chasmanthum*	*Mohri*	Roots	35
5	*Picrorhiza kurrooa*	*Kour*	Roots	35
6	*Valerian wallichii*	*Mushakbala*	Roots	41
7	*Podophyllum emodi*	*Bankakri*	Roots	150
8	*Colchicum luteum*	*Suranjan*	Corms	230
9	*Berberis lycium*	*Rasaunt*	Root	35
10	*Inula royleana*	*Maline*	Roots	41
11	*Dryopteris filixmas*	Male-fern	Rhizomes	8
12	*Digitalis purpurea*	Foxgloves	Leaves	60
13	*D. lanata*	Foxgloves	Leaves	60
14	*Rheum emodi*	*Rewand*	Roots	40
15	*Macrotima benthami*	*Kazban*	Whole plant	26
16	*Juniperus communis*	*Vither*	Berries	17
17	*Thymus serphyllum*	*Banajwain*	Whole plant	15
18	*Datura stramonium*	*Dhatura*	Seeds	25
19	*Datura stramonium*	*Dhatura*	Leaves	20
20	*Ephedra vulgaris*	*Asmani booti*	Whole plant	18
21	*Jurinea macrocephala*	*Dhup*	Root	70
22	*Lavetera kashmiriana*	*Resha khatmi*	Root	70
23	*Taraxicum officinalis*	Dandelion	Root	24
24	*Phytolacca acinosa*	*Mithakafal*	Root	15
25	*Ajuga bracteosa*	*Jani adam*	Leaves	20

The list is not an exhaustive one. Other drugs like *Cassia fistula*, *Terminalia* sp., *Viola*, etc., which are also extracted from the forest, have not been included.

With prolonged tours and detailed surveys many more drugs are likely to be discovered and added to this list. Herbarium specimens of most of these plants have been collected and are available for consultation in the Drug Research Laboratory.

The help and facilities offered by the Himachal Pradesh Government during the tours in Chamba a few years ago is gratefully acknowledged. Thanks are due to Col. R. N. Chopra and Father H. Santapau for their valuable advice and helpful criticism during the course of preparing this note.

TREATMENT AGAINST DECAY AND FIRE OF GRASSES AND PALMYRA LEAVES USED FOR THATCHING ROOFS

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SUMMARY

In this paper details on the experiments to treat *Nanal* grass and palmyra leaves with suitable chemicals so as to protect them against fungi, insects and fire, are given. For purposes of comparison data on the annual charge for various common residential roofings are also worked out.

In an earlier publication mention was made of the importance of the treatment of grasses and palmyra leaves used for thatching houses, godowns, etc., against decay and fire. It is estimated that untreated grasses decay in about 3 years and the palmyra leaves in about 2 years time. Some godowns, where tobacco is stored, it may be mentioned, have each a storage capacity of about 300,000 lbs. and the duty payable on the tobacco itself amounts to about Rs. 22·5 lacs. The protection of these buildings against decay and particularly against fire accidents, therefore, requires no emphasis. Experiments were, therefore, undertaken to find the minimum quantity of chemical treatment necessary to give protection against decay and fire so as to obtain a reasonably satisfactory service life.

The Imperial Tobacco Company of India Rajmundry Branch supplied the necessary material for the experiments. The local name of the grass is "Nanal grass". Details of the experiments conducted on chemical impregnation of the grasses and the palmyra leaves are given in Table III. The chemical composition of the impregnating water solution consisted of:

Boric acid	.. 3 parts by weight	in 100 parts of water
Copper sulphate	.. 1 part ,, ,,	
Zinc chloride	.. 5 parts ,, ,,	
Sodium dichromate	.. 6 ,, ,, ,,	

Since the above composition contains such toxic ions as copper, zinc and boron, which have proved to be very effective against decay of timber by fungi and deterioration by termites and other insects, it may reasonably be assumed that with grasses and palmyra leaves also similar results can be obtained. Further, treated (Ascu) thatch grass laid on experimental, roofs in the open, in our test-yard is in a very sound condition after two years. The untreated grass similarly exposed decayed after 6 months. The chemicals used also appear to be satisfactorily fixed since the treated grass mentioned above has already withstood over 150 inches of rain. Again, the treated grass appears to stand weathering since after two years exposure it is as good as freshly treated material. Treated timber shingles in experimental tests here have already given a life of over 18 years and from their present appearance they are expected to last several years more. In laboratory tests the fire proofed grass was subjected to 24 hours soaking and was also leached under running water (at 2 gallons per hour), for 24 hours. It gave satisfactory results when tested against fire. The treated grass can, therefore, be expected to have an average life of about 18 years.

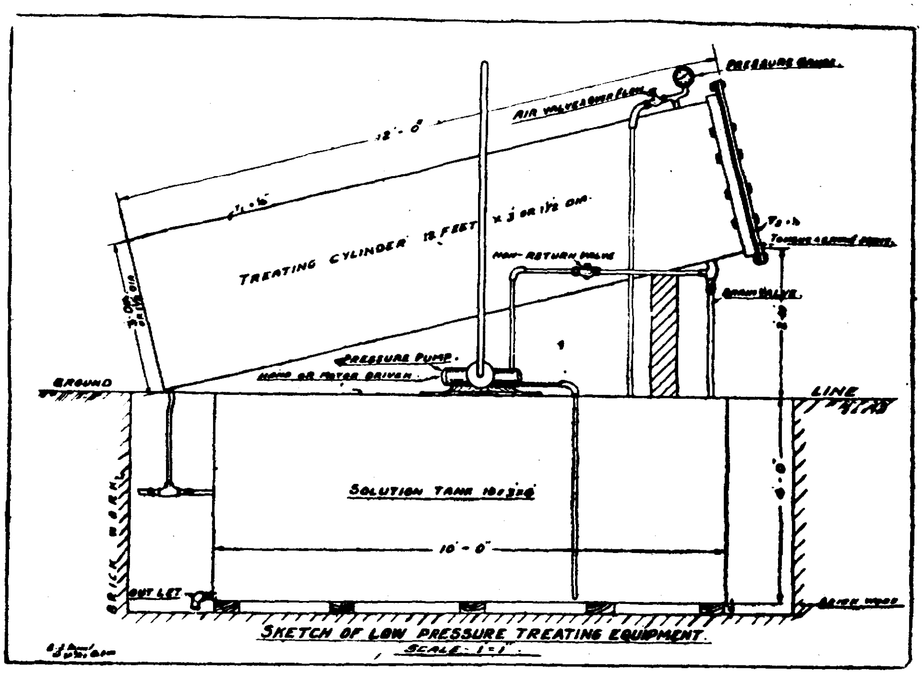
The testing of the fire proofed grass and palmyra leaves was done on a qualitative basis since no standard tests, as with timber specimens, have so far been evolved. The treated grass in laboratory tests was exposed to over 700°C. and when removed from the fire did not support the flame. The untreated grass, as is to be expected, burnt off instantaneously on

exposure to a mild flame. Treated and untreated experimental thatch and palmyra roofs were also set on fire. While the treated material withstood the flame from a burning torch of jute dipped in kerosene for several minutes, the untreated material was readily consumed in the flames (the treated grass, however, behaved better than the treated palmyra leaves). After several tests as described above, conducted in the presence of the representatives of the tobacco firm, it was considered sufficient to secure an absorption of 1·0 lb. of dry chemicals for treating 10 lb. of Nanal grass or 4 palmyra leaves, to resist most accidental fires. Higher absorption of the chemicals would, of course, give increased resistance, but it would not normally be required.

As in the case of timber, the grass and the palmyra leaves should be in sound condition and should be dried to a moisture content of about 12–15 per cent before treatment. While prolonged dipping in a 20 per cent solution of the composition mentioned earlier gives satisfactory absorptions, for commercial purposes, however, a 15 per cent solution should be used employing an antiseptic pressure treatment under 30 lbs./square inch for 30 minutes.

A suitable equipment for treating the grasses and palmyra leaves under these low pressures is shown in Fig. 1. The equipment can be manufactured in India. The cost of it would be about Rs. 5,000 for a 3 feet diameter and 12 feet long cylinder together with accessories.

FIG. 1



A low pressure treating equipment specially suitable for treating house-building timbers, grasses, etc. Cost about Rs. 5,000.

For the operation of the plant a trained graduate in science assisted by two labourers will be required. At the rate of 50 cubic feet of the material per charge, 10 charges per 8 hours in a single shift can be treated. Thus working 300 days a year, sufficient treated material can be had to thatch 55 sheds each with a roofing area of 5,200 square feet. The cost of labour

and supervision charges works out at Rs. 0·02 per cubic foot (Technical man Rs. 5 per day and two labourers at Rs. 2/8/- a day). The cost of chemicals at the present market rate comes to Re. 1/- a lb. To this may be added interest at 5 per cent and depreciation at 10 per cent on the capital outlay which consists of Rs. 5,000/- for the purchase of the plant and Rs. 5,000/- on account of land and buildings required for installation of the plant and the storage of chemicals respectively. Table I below gives details on the costs for roofing 5,200 sqaure feet of a godown with a ground space of 104 × 30 feet square feet.

TABLE I

		Nanal grass thatch	Palmyra thatch
1	Quantity of grass (thickness 6″) palmyra leaves (thickness 3″) required for roofing one godown	lb. 27,500	10,000 leaves
2	Cost of grass/palmyra leaves required ..	Rs. 687/5/-	Rs. 450/-
3	Labour charges for thatching	Rs. 650/-	Rs. 100/-
4	Total cost of roofing one godown (items 2 and 3)	Rs. 1,337/5/-	Rs. 550/-
5	Quantity of chemicals required for treatment of the roofing material to give protection against fungi, insects and fire	lb. 2,750	lb. 2,500
6	Cost of chemicals under (5)	Rs. 2,750/-	Rs. 2,500/-
7	Quantity of chemicals required for protection against fungi and insects only ..	lb. 916·6	lb. 833·3
8	Cost of the chemicals under (7) ..	Rs. 916/10/-	Rs. 833/5/-
9	Interest and depreciation charges on capital outlay per godown	Rs. 27/8/-	Rs. 27/8/-
10	Labour and supervision charges for roofing one godown calculated at Rs. 0·02 per cu. ft.	Rs. 55/-	Rs. 55/-
11	Total cost of treatment involved for protection against fungi, insects and fire ..	Rs. 4,169/13/-	Rs. 3,132/8/-
12	Total cost of treatment involved for pretection against fungi and insects only ..	Rs. 2,336/7/-	Rs. 1,465/13/-
13	Expected life of untreated thatch roof ..	3 years	2 years
14	Expected life of treated thatch roof ..	15–18 years	12–15 years

It may be of interest to study the comparative annual charges (*vide* Table II) for various types of residential roofings. This has been worked out using the formula $A = P\left(r + \frac{r}{(1+r)^n - 1}\right)$ in which A is the annual charge, or cost per year ; P is the first cost of the material ; r is the rate of interest (expressed as decimal) and n is the number of years of service expected from the given installation. Details of roofing costs for materials other than thatch grass/palmyra leaves were obtained from the local C.P.W.D.

If necessary the thatch grass can also be suitably dyed.

TABLE II

Comparative Annual Charges of Various Residential Roofings per 100 square feet of Surface

Serial No.	Type of roofing	Initial cost of 100 sq. ft. of roofing in Rs.	Service life expected years	Rate of interest per cent †	Annual charge per 100 sq. ft. of surface Rs.*	Order of resistance to fire §	REMARKS
1	Corrugated galvanized iron and Ceiling with ¾″ thick timber planking	75 100 175	50 ..	5 ..	4·11 9·56	4·0 ..	Should be protected against atmospheric corrosion by paints. Generally, for greater comfort, a layer of wooden shingles are preferred over the roofs; small repairs may necessitate replacement of complete sheets; supply position not satisfactory and require costly machinery for manufacture.
2	Corrugated cement asbestos and Ceiling with ¾″ thick timber planking	90 100 190	30 ..	5 ..	5·85 12·3	4·0 ..	Losses in transport and storage due to breakage; necessity to replace whole sheets due to damage by cracks, holes, etc., under hail storms.
3	Single Allahabad tile roofing on wooden battens and Ceiling with ¾″ thick timber planking	36 100 136	20 ..	5 ..	2·89 10·9	4·0 ..	Losses due to breakage in transport, storage and by monkeys during service period; gives room for living and breeding of rodents, scorpions, etc.
4	Six inches thick fire proofed thatch grass‡	80	15 to 18	5	7·7 6·84	3	Actual life against deterioration due to weathering and fire yet to be obtained; also whether rodents scorpions are repelled by chemical treatment is to be seen.
5	Six inches thick antiseptically treated thatch grass‡	46	15 to 18	5	4·34 3·84	1·0	In addition to what has been said above, under 4, actual service life is to be obtained. Data should also be collected for treatment of various species of thatch grasses.
6	Six inches thick untreated thatch grass‡	25	3	5	9·18	1·0	Deterioration due to fungi, insects, weathering and fire is very great. Source for housing and breeding rodents, scorpions, etc.
7	Three inches thick fire proofed palmyra leaves	60·2	12 to 15	5	6·79 5·80	2·5	Impregnation of chemicals is more difficult than in grasses; more prone to damage during transit and weathering during service. Actual service life of treated material has yet to be obtained; also the effect on rodents, scorpions, etc., due to treatment is to be seen.
8	Three inches thick antiseptically treated palmyra leaves	28·2	12 to 15	5	3·18 2·72	1·0	Do.
9	Three inches thick untreated palmyra leaves	10·6	2	5	5·70	1·0	Decay, insect attack and inflammability are pronounced. Not available throughout the country.

* "The cost per year or the annual payment required to extinguish an interest bearing debt during a period of years corresponding to the life of the material in service".

† This includes interest at 3 per cent and expenses for annual maintenance charges at 2 per cent on capital.

‡ *Nanal* grass.

If a ceiling under the thatch grass or palmyra roof is found necessary, it can be put up using hessian cloth which costs Rs. 20–30 including a coat of paint.

§ These are arbitrary figures fixed on experience and indicate the relative resistance of each material when exposed to fire.

TABLE III

Details of the treatment of ' Nanal ' grass and palmyra leaves with fire-proof-cum-antiseptic compositions

Serial No.	Grass or palmyra leaves treated	Moisture content at the time of treatment	Concentration of the treating chemical solution %	Process of treatment	Pressure applied lbs./in. sq.	Period of treatment in hours	Absorption of dry chemical per 5 lb. grass or one leaf
1	*Nanal* grass	..	10	Full cell	150	2·0	1·64
2	,,	16·7	15	Lowry	150	1·0	1·40
3	,,	,,	10	Air pressure over preservative	50	1·5	0·95
4	,,	,,	,,	,,	,,	1·0	0·90
5	,,	,,	,,	,,	,,	0·5	0·95
6	,,	,,	,,	,,	25	0·5	0·80
7	,,	,,	15	Soaking	..	6·0	0·30
8	,,	,,	,,	,,	..	48·0	0·64
9	Palmyra leaf	20·2	15	Lowry	150	1·5	0·40
10	,,	,,	,,	,,	50	1·0	0·23
11	,,	28·8	10	Air pressure over preservative	50	1·5	0·25
12	,,	10·0	15	Soaking	..	24·0	0·11

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A CASABIANCA OF THE FOREST

BY J. N. SINHA
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The novelist had toyed with tigers and wild elephants and thrilled his readers with hair-raising tales. One of his heroes had, in the dark forest, braved a ferocious tiger with bare arms and humbled it. Another had caught hold of the trunk of a trumpeting tusker and shouted him down to abject docility. But when the novelist came to Saranda of seven hundred hills he discovered that his obedient jungle animals were not behaving themselves. Just the other day three women had been attacked by a man-eating tiger at the outskirts of a village barely a mile from the forest rest-house where we were camping. These women had gone out to collect faggot in the dew-bejewelled sunshine of a winter morning. Behind a bush the tiger lurked, as these wily man-eaters are wont to do. Suddenly he sprang upon the unsuspecting women, killed all the three and carried away one. Nor were the tiger's depredations confined to any known locality. The entire forest from end to end had become his field of operation. If to-day there occurred a human kill in the extreme north, a week later similar news would travel up from the extreme south. Terrible awe had settled upon the country-side. The trees, the bushes, the hills, all seemed to stand still in fearful expectancy, helpless ally of the dreaded animal. Dwellers of the forest region who normally know no fear had turned into pitiable cowards. None dared to be out-of-doors alone, and by sun-set everybody was securely locked up in his house.

At our next camp, Tirilposi, we were told in detail by the frightened villagers how a woman, cutting grass just outside the compound of our forest rest-house, had, in broad day light been carried away by the tiger even within the view of some who had run up in vain at the piteous cries of the unfortunate woman.

About wild elephants, too, tales of dire happenings were floating in from all directions. Two labourers were returning from work in the forest. Suddenly a rogue tusker, who had cleverly camouflaged himself behind foliage by the roadside (and it is remarkable how behind scant shelter huge elephants can hide themselves) suddenly avalanched upon them. One of the two, by instinct or by sheer accident, caught hold of the tusk and dangled therefrom until thrown aside when he took to his heels. But the other came in for severe pulping. So hideously was he mangled that pieces of his heart and liver were found strewn a hundred yards from the scene of occurrence.

This then was the setting in which the novelist was to discover the beauties of Nature.

If I had prior knowledge of the situation the visit would probably have been deferred to a more peaceable occasion. Yet danger has its own fascination and the sight of a roaming tiger or of a wild elephant in forest is an experience to be treasured and cherished. If, that is to say, the thing can be done from a point of safety.

But the malice of chance hoisted us to the very scowl of calamity.

We were returning to camp from the day's outing. The road we selected, Mundu Edal-Hendekuli, was the wildest and most beloved of the wild elephants. From the safety of our seats on the Jeep we hoped with luck to see a tiger or surely an elephant. The road went winding up and down the steep hill-side. Narrow the road was, perilously narrow and tortuous, with a high ridge on one side and precipitous slope leading down to the Samta nala on the other. The novelist greedily drank the wild beauty of Nature and his romantic fancy wove fabrics of

literature. But soon enough we saw fresh elephant dung in the roadway. Obviously an elephant had gone ahead and who could tell that at the very next bend we might not come upon it ? A tiger, howsoever dangerously man-eating he might be, is a song from the safety of a car. But the black Himalaya of wild elephant standing in the middle of a narrow hill road is a different proposition. You can neither go ahead nor turn back. All your devices freeze, all your weapons are downed, and your life rolls round in liquid drop inside the hollow of your palm.

Fortunately nothing happened and with bated breath we reached Hendekuli.

At Hendekuli, where the hills relent somewhat, were the remains of a labourers' camp

These fascinated our novelist. Somehow even the sight of these deserted huts seemed to bring us into touch with the human world. For around us, within a radius of ten miles, not a human soul breathed, no man's abode was ever made. Hill rose upon hill and abyss led to yet deeper abyss. There are tall trees around and reckless rocks, and in the deep narrow valley restless streams had cut gorges and meandered endlessly. We were the strange actors in that Nature's amphitheatre.

A forest rest-house was under construction at Hendekuli. We went up to examine it. The steps had been broken down by elephants, there was fresh dung around and the brutes had even experimented with the luxury of veranda shelter.

The Jeep rolled forward. Shortly after our eyes were arrested by large fresh pug marks of a full grown tiger right in the middle of the roadway. A few drops of rain had fallen only a while ago and obviously the tiger had just gone ahead. We pulled up to examine. Having travelled some way along the road the tiger had swung away into the jungle. Might be he had done so at the sound of our Jeep. Might be he was lurking just at the moment in the near-by bush. Discretion summoned us speedily back to the Jeep.

Further ahead, more elephant dung and freshly broken twigs and small branches strewn along the road. Unmistakable sign that the wild elephant was close by. The novelist asked – "What is to be done now" ?

"We have to prepare ourselves", I replied.

"Prepare for what" ? asked the novelist agape.

"Prepare to run away".

I explained the technique. From the elephant always run down-hill. On the level or up-hill he will surely overtake you. Only on the down slope the mass of his body frightens him. But in these tangled woods, with murderous precipices and menacing rocks, this perfect technique sounded to the novelist as a mere synonym of death.

Warily, warily, the Jeep crept forward. Miles had never been longer. Ultimately we espied a few grass-and-twig huts in a grove of tall sal trees by the road, and there was also an illusion of a child peeping out from one of them. We stopped and made enquiries. For sometime there was no response. Then a boy of about twelve hesitated out.

"Who else is there" ? asked the novelist.

"None", replied the boy.

"None" ! mused the novelist. "And where are your parents" ?

"They have gone out for work", replied the child in the Ho language of Singhbhum Adibasis.

"What is your name" ?

"Dumbi Ho"

"And why have they left you behind" ? asked the novelist in deep perplexity.

"To guard" the boy replied, simply and confidently.

Picture the pathos of the scene. That terrifying deep forest, those man-eating tigers making cowards of the country-side, wild elephants creating hovoc, and this child to be sitting here alone, hour after hour, to guard the parents homestead.

"Do not elephants come here" ?

"They do", he said with cool indifference ; " just last night our neighbour's hut was pulled down".

And he showed with his finger the afflicted hut.

"What will you do if the elephant attacks" ? asked the novelist again.

"I shall run away" said the child, without trace of fear or anxiety, as if he were merely describing a strategy of war.

The novelist spoke no further. Returning from the hut he dramatically marched forward on the road towards our camp.

We shouted and asked him to come back and get into the Jeep.

"No", he said, still marching and looking ahead ; " I shall go on foot, alone".

"All the way to the camp, 5 miles away, on foot in this gathering darkness, alone" ?

"Yes".

Our surprise now knew no bounds. Whence had come this sudden overwhelming flood of courage ? But he would not return and round a corner soon vanished.

We ran and caught up with him. Still marching vigorously and looking steadfastly ahead, he said : "Let the tiger kill me ; let the elephant crush you. Let the tiger and elephant between them denude the world of human population. Yet so long as one Dumbi Ho is alive, man will remain immortal".

TIMBER EXTRACTION FROM DIFFICULT SITES

The use of Modern Cableway Systems

BY COL. A. H. LLOYD, O.B.E., M.C., M.A.
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The general scarcity of timber during the post-war years and the resulting high prices have led to a search for new methods of getting timber from forests formerly considered to be economically inaccessible. Mechanization of timber extraction has been particularly successful in the mountain forests of Yugoslavia, Austria and Switzerland. Many of these forests are in protective zones where only selective fellings are permitted and the quantity of timber available on any one site is often too small to pay the heavy cost of construction of mountain roads or even of timber chutes or log slides.

Cableways have been used for many years in these countries but consisted in the past of either simple gravity cables, for firewood extraction and other light loads or the elaborate bi-cable systems with permanent terminal stations and heavy trestle supports which are still common in Austria and in the Haute Savoie.

A completely new system, named after the inventor, Mr. Wyssen, was first produced in Reichenbach, Switzerland, in 1942. This mechanized cableway is now used extensively in Central and Southern Europe, and during the past year has been installed in Central Africa, in Canada and in the U.S.A. Two pioneer sets are now in operation in the highlands of Scotland.

The Wyssen system consists of a main gravity cable line combined with a portable power-driven winch and brake-drum, similar to a small American "skidder" or yarder. The skidder is anchored at the top of the runway and hauls the empty log carriage up the main cable by a traction-line from the winch. The same traction-line passes down through the carriage and is fitted with a terminal hook or "fall-block" which lifts the load from the ground up to the log-carriage, and the line then controls the descent of the logs to the off-loading point.

To install the cableway the first operation is to get the skidder up to the site of the top terminus of the main cable. The skidder is mounted on steel runners and the winch is used to haul the whole unit up the mountainside by attaching the end of the winch cable to successively higher anchorage trees. When it reaches the site selected for the cable terminus, the skidder is anchored and then used to haul up the heavy 1 inch diameter main cable from the base. The special log carriage, designed to carry loads up to 1½ tons, is then suspended on the main cable and hauled up by the skidder.

By means of an ingenious interlocking "stop", which is fitted on the main cable line and easily moved up and down the line by a light control wire from the ground beneath, the log carriage can be halted at any point along the main cable. This important device enables loads to be picked up, by the hook on the traction cable, from anywhere along the route of the cableway. When the rising loaded hook reaches the travelling carriage, it strikes a coupling lever and interlocks automatically with the carriage which, by the same automatic action, is immediately released from the "stop" and runs by gravity down the cable with the load.

The main cable is suspended at a minimum height of 30 feet above the ground, and is usually much higher, so logs can be "side-lined" or skidded by the traction cable about 150 feet from either side of the main line, and thus a strip of forest 300 feet wide and up to

$1\frac{1}{2}$ miles in length can be covered by a single setting of the cable and without any manual dragging or lifting of the timber. As the system is simple and there is only one main cable, the whole cableway can be set up by four or five men in a few days for short straight hauls, and in two or three weeks for hauls of one mile or over, where several intermediate supports are required.

The length of cable is limited by the winch drum capacity and, with the standard Wyssen model, the maximum hauling distance is about 7,200 feet. As only four men are needed to load and operate the cable, the output per man is very high and the average quantity of timber hauled per man-day varies from 300 to 400 cubic feet depending on the type of load and distance hauled.

Very steep slopes can be safely logged and changes of gradient, or even changes of direction, are not a serious difficulty. Timber can be hauled uphill, out of a valley or ravine, with the same equipment as downhill traction but for hauling on level ground a second winch-drum is necessary to haul the empty carriage back to the loading point.

A great advantage in this type of high cableway is that less damage is done to the remaining trees in the forest than by any other means of hillside extraction, and the logs are delivered clean and undamaged. Also low grade and small-sized timber, normally left behind in the forests can be bundled together and brought out at a profit.

The Wyssen equipment includes special light metal alloy cable supports and an ingenious tensioning device for the main cable. All the component parts of the system are especially designed for toughness and durabilty, and work together with the precision of a Swiss watch; and this is essential for successful high cable operation. Imitations of the Wyssen system are already numerous but up to the present none has been successful. Apparently this has been due to inferior materials and workmanship, and the difficulty in avoiding the many patented devices in the Wyssen system.

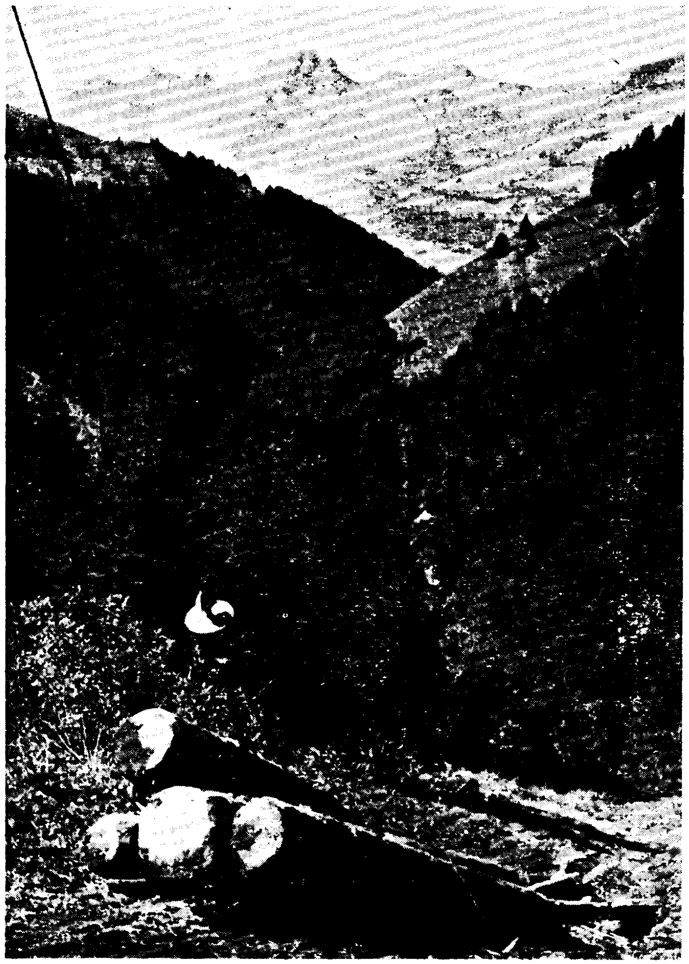
The "Cable Lasso" is another cableway of Swiss manufacture but is completely different from the Wyssen system and is used for much smaller loads, such as pit-props, fire-wood, and billets for paper pulp. It is particularly suitable for sites where a large quantity of small sized material has to be transported over difficult terrain.

It consists of a single endless moving cable of about $\frac{1}{2}$ inch in diameter and up to 4,000 yards in length. It is operated by gravity on steep hillsides, but where the slope is insufficient for gravity power alone, the traction is assisted by a winch which is usually anchored near to the off-loading station at the base.

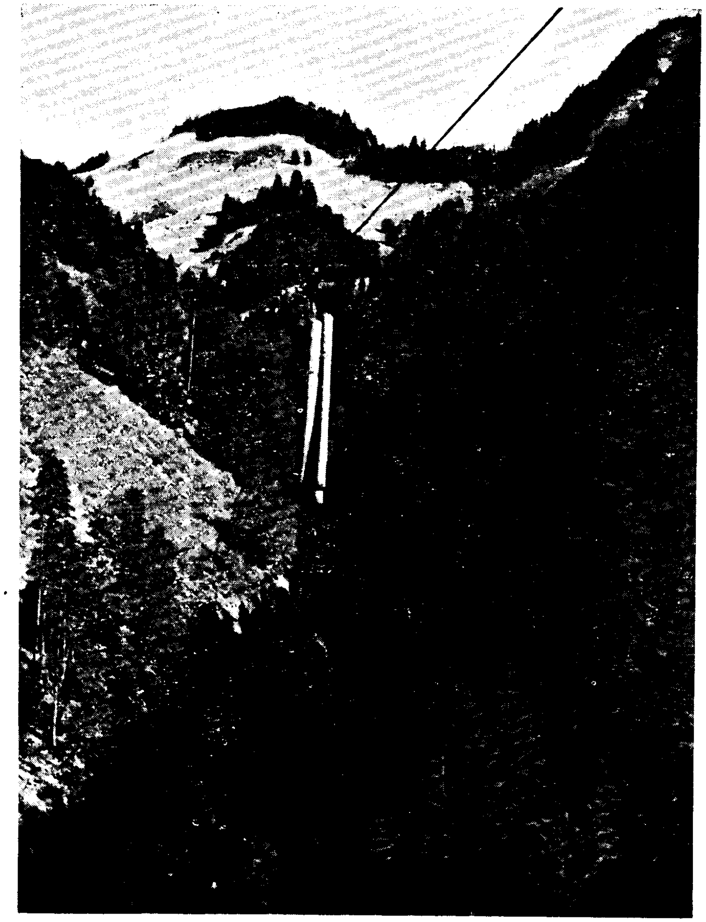
The cable carries a continuous series of small individual loads, up to a maximum of about $1\frac{1}{2}$ cwt. In addition to timber extraction, the "Lasso" system is commonly used in foundries and also for carrying bananas and other agricultural crops, particularl the Belgian Congo.

The "Lasso" has two original features which make it adaptable to forestry work. The first of these is a specially designed roller, or pulley, on which the moving cable is suspended at a height sufficient to keep the loads off the ground. The cable is kept from slipping off the pulleys, during sudden changes of tension or of direction, by long projecting teeth or spikes on both outside flanges, and the pulley turns on a roller-bearing cone which allows of a very free movement of the cable.

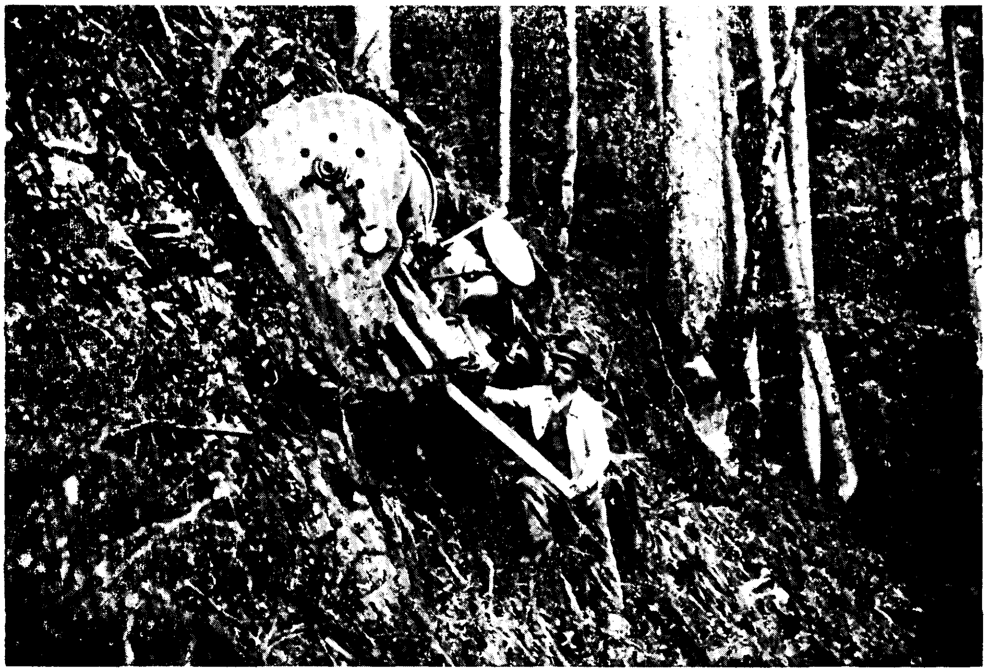
The second special forestry adaptation is a light portable tubular-steel bracket support which can be quickly clamped to trees or upright posts, of 1 to 3 feet in diameter. As changes



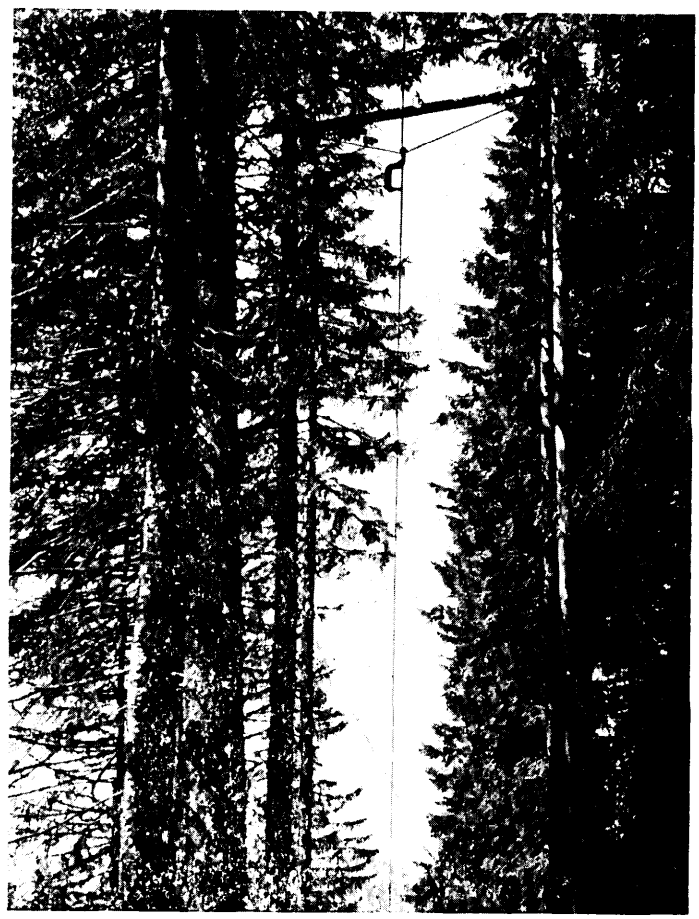
Logs, bunched together by choker lines, being hauled by traction cable up to the main Wyssen cable 100 ft.



A load weighing about 1 ton sliding down through the forest by gravity but controlled by the traction line.



A Wyssen skidder unit, mounted on steel runners, hauling itself up a hillside by winch cable.



Two trees, strutted apart with a 9 ft. pole, form the support for a Wyssen cable.

of direction are easily negotiated, the endless cable can be set up on any ground plan, circular, rectangular or irregular, the supports being placed at each change of direction or gradient, and at intervals of from 60 to 150 feet, depending on the weight of the load.

Each load is attached to the moving cable by a chain sling and long steel hook at any point along its length, and is unhooked again at the off-loading point without stopping the cable. These twisted steel rod hooks are of an original design which enables them to pass smoothly over the toothed pulleys and still remain firmly fixed to the cable even on steep gradients.

The portable winch, powered by a small diesel air-cooled engine, is mounted on two easily detachable wheels and can be hauled as a trailer behind a lorry. The speed of the cable is maintained at about 1½ to 2 miles per hour and, if the individual loads are heavy, a portable loading platform of a convenient height is advisable to reduce the fatigue of continuous mechanical loading. Production figures vary considerably with the location and the type of load but with a crew of eight men about 60 cords of firewood per day have been transported for an average distance of about 1,000 yards.

A "Lasso" cable with its small winch make a very portable unit and for hillside plantations or on rough broken terrain, or even across soft boggy ground, it would appear to have good possibilities in the extraction of small timber up to a maximum distance of 2,000 yards. The efficiency of the method appears to depend chiefly on the experience of the crew and the actual lay-out of the operation.

The "Lasso" system is now used extensively for pulpwood extraction in Yugoslavia and also in France, particularly in the Vosges and the Pyrenees. We understand it is probable that a first installation will be tried in Scotland during the present year.

NOTES ON THE BIOLOGY OF SOME GALL-MIDGES (*ITONIDIDAE; DIPTERA*) OF SHISHAM (*DALBERGIA SISSOO*) IN UTTAR PRADESH, INDIA

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Mani (1942) described two new midges (*Itonidae*) from shisham (*Dalbergia sissoo*), namely *Contarinia dalbergiae* sp. nov. and *Sissudiplosis chatterjeei* gen. et. sp. nov., from Dehra Dun. He also described new species of Chalcid parasites (e.g., *Holospis indicus* sp. nov. and *Systasis dalbergiae* sp. nov., from *Contarinia dalbergiae*; these Chalcids were bred by me from galls of *Contarinia dalbergiae*. A few observations on the biology of these and on other gall-midges are given here.

1. *Contarinia dalbergiae* Mani—It destroys the flower buds of shisham and inhibits seed formation. The occurrence, in March and April, of dried, brownish-black flower-buds, on shisham trees, attracted my attention in Dehra Dun and its vicinity in 1938–39 and 1941–42, and in Allahabad in 1938–39. The flower-buds appear on shisham trees by about the third week of February and at this time the midges also emerge. The infected buds begin dying from early March. On dissection, these buds, yielded about 8 maggots per bud, feeding on the internal organs of flower. Completely dried up buds, collected from the field, yielded, in cages, the Chalcid parasites, *Systasis dalbergiae* Mani and *Holospis indicus* Mani, and two unidentified species, e.g., *Tetrastichus* sp. (*Eulophidae*) and *Monodentomerus* sp. (*Torymyidae*). The parasite emerges by making a circular hole on the bud.

In the bud attacked by the midges there are no apparent external symptoms of attack. The maggot is white in its early stage and pink in the last stage. The older maggots escape from the infected bud and drops, by jumping, on the ground which they penetrate for pupation. Before the emergence of the adult, the pupa wriggles out to the surface of the soil and exposes half its body-length. The pupal skin is white. In the laboratory adult midge emerged in 10 days in March–April from the date of caging of the unhealthy green buds.

The *Contarinia*-infected buds when parasitized with the Chalcids become dried up, are slightly swollen, and brownish-black in colour. The parasites also emerged about the same period as the midges in the laboratory from the date of caging of infected buds.

The maggots dissected out of the buds varied in size as follows:—Length 1·3–2·4 m.m.; width of body (in middle) 0·4–0·6 m.m.; head width 0·04–0·05 m.m. The sternal spatula, situated ventrally in the prothoracic segment, is yellow in colour, and occurs in the older maggots (length 2·3 m.m. and above).

2. *Sissudiplosis chatterjeei* Mani—It forms leaf-gall in shisham. At the beginning of the new flush, when new leaf-buds open, the infested leaves swell up like a bladder. Several minute, white, maggots are found in a leaf-gall; they jump out as soon as the gall is opened and fall on to the ground for pupation. The infected leaves dry up on the tree. In the laboratory, Chalcid parasites emerged in cage containing the dried up, galled-leaves. Recorded in March, in Dehra Dun.

3. *Asphondylis* sp.—This rare midge forms galls in young fruit-pods of shisham and inhibits maturation of seeds. It is also parasitized in nature by a Chalcid species. Recorded in April, in Dehra Dun.

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SALE OF ELEPHANTS – MADRAS FOREST DEPARTMENT

The following Government elephants will be offered for sale by public auction at Nilambur on Wednesday the 27th May, 1953 by the Conservator of Forests, Ootacamund Circle, Ootacamund. Nilambur is in South Malabar and can be reached by buses from Kozhikode Railway Station, distance being 45 miles. Further particulars may be obtained from the Conservator of Forests, Ootacamund Circle, Ootacamund.

Serial No.	Name of Elephant	Sex	Age Years	Height ft.	Height in.
1.	Jansirani	F	26	7	8
2.	Lakshman	M	10	5	8
3.	Durga	F	3	4	10
4.	Maya	F	$1\frac{1}{2}$	4	7
5.	Asokumar	M	$1\frac{1}{3}$	4	$8\frac{1}{2}$
6.	Arjun	M	17	6	11
7.	Bhisma	M	26	7	10
8.	Suseela	F	9	6	0
9.	Jayaram	M	36	8	11
10.	Uma	F	36	7	9
11.	Genesh	M	1	3	10
12.	Krishna	M	1	4	12
13.	Gomathi	F	10	6	$1\frac{1}{2}$
14.	Gopu	M	2	4	9
15.	Sarada	F	33	7	6
16.	Nalini	F	30	7	6
17.	Bhairavan	M	11	6	1
18.	Rukku	F	17	6	7
19.	Sarala	F	23	7	0
20.	Shivaji	M	2	4	4
21.	Pradjumna	M	$2\frac{1}{2}$	4	$11\frac{1}{2}$
22.	Srinivasan	M	2	4	10
23.	Malini	F	4	5	0
24.	Subhas	M	3	4	10
25.	Dilip	M	14	6	6
26.	Tyno	M	52	8	2
27.	Radhika	F	5 months	3	6
28.	Kumar	M	$3\frac{1}{2}$	4	11
29.	Kunthi	F	42	8	1
30.	Balan	M	$1\frac{1}{2}$	4	3
31.	Lakshmi	F	33	8	1
32.	Parasuram	M	2	4	$1\frac{1}{2}$
33.	Bhanumathi	F	19	7	10
34.	Parimala	F	19	7	1

M = Male.
F = Female.

V. V. SUBRAMANIAN,
Chief Conservator of Forests, Madras.

INAUGURAL ADDRESS

BY SHRI C. D. DESHMUKH
Finance Minister, Government of India

On the occasion of the First Annual Session of the Soil Conservation Society of India held at New Delhi in February, 1953

1. It gives me great pleasure in opening the session of the Soil Conservation Society of India. I am glad that an All-India Society with the objects of fostering study in soil erosion problems and promoting work on soil conservation was formed about a year ago and that this society has succeeded in bringing officers in the different Departments connected with soil conservation from State Governments, workers in the field of soil conservation from the Universities and Research Institutions, representatives from the River Valley Authorities and other organizations together on a common platform. The present session of the society is a happy and significant occasion. It is being held in New Delhi, soon after the publication of the First Five Year Plan in which recommendations on a national programme for soil conservation have been made and a beginning has been made towards the formulation of a national soil conservation policy. I do hope that the delegates, who have assembled here at this session, will consider the recommendations of the Planning Commission on the subject very carefully in their discussions and see what step they should take as they go back to their States and Organizations towards the implementation of these recommendations.

2. It is unfortunate that there is so little general realization in this country as yet of the erosion problem, and the extent of the damage which is continuously done by our present land use practices. One has only to travel over any part of Peninsular India or in the Himalayan foot-hills to realize the immensity of the erosion problem. A flight over the Peninsula – say from Delhi to Madras – leaves on the mind an indelible image of a virtually desolate landscape : brown, bare serrated hills follow in an almost endless succession. The monotony is broken here and there by patches of green wherever there is some cultivation or some forests have been preserved from destruction. It is an awesome and in a sense dreadful impression as it brings in vivid relief the story of the misuse of our land over the ages. These uplands and slopes which are barren and unproductive now, must have been covered with dense forests (about which we read in the Ramayana, the Mahabharata and the Puranas) in the past. The sages lived and preached amid these forests, along the banks of streams. But now these hills support only coarse grasses and brush, fit only for grazing by sheep and the ubiquitous goat. It is a grim picture, and reminds one of the destruction that goes on every day, and will go on until we improve our land use practices.

3. To my mind, one of the first things that needs to be done in tackling the problem of erosion is an assessment of the magnitude of the problem – of the extent of areas affected by erosion in different parts of the country, the types of erosion and the degree of damage done in each. Such an assessment is an essential pre-requisite for correct formulation of policies and administrative action, as also for creating adequate realization among the public of the seriousness of the erosion problem. Those of us who are familiar with the problem know that damage from erosion is very widespread. The cultivator whose land is eroded away or yields less than it used to because the soil looks 'thin' and 'not so good' may also be painfully conscious of its existence. But the generality of people, and these include most legislators and administrators who formulate and execute policies, are not conscious of the erosion problem and would not be until the story is told to them fully and in detail. Finally, in a country as large as India, with its great contrasts in topography, soils and climate, the nature of erosion problems and the

measures necessary to tackle them very greatly in the different parts. Within my own State of Bombay, there are large differences in this respect. In the Deccan, besides control over erosion, conservation of moisture is a very important problem, because this is an area of deficient and precarious rainfall. In the Konkan, on the other hand, moisture conservation during the cropping season is no problem (except for detailed water control) as this is an area of heavy rainfall, although water is badly required and should be stored for use for drinking purposes in the dry season. The main problem here is prevention of soil-wash down the hill slopes which is very heavy because of the torrential monsoon rains. In the extreme northern parts of the State (along the borders of Rajasthan and Saurashtra) the main problem is protection of the land from desert sands which blow from the adjoining desert areas. In the catchment areas of our big river valley projects the problem is to prevent soil wash threatening the life of the dams. A knowledge of these varying problems, of their relative magnitudes and of the measures needed for tackling them is essential for formulation of erosion control and soil conservation programmes at both the State and Central Government levels.

4. Perhaps the best way for making such an assessment would be, as we have recommended in the Planning Commission Report, through a survey of the reconnaissance type which should be finished in a specified period of say two or three years. The survey should demarcate erosion affected areas, bring out the character and degree of erosion damage in each and indicate broadly the measures needed for tackling the erosion problems. The survey should make full use of the existing information on soils and soil erosion available with the Forests, Agriculture, and Irrigation Departments of State Governments and with Universities and Research Institutions.

5. It may be thought that such a survey would retard progress on soil conservation, because no work would be done while the survey is going on. This is not correct. A certain amount of soil conservation work (contour-bunding and terracing in Bombay, afforestation and control of hill torrents in the Punjab ; reclamation of ravine lands in the U.P., etc.) is going on in a number of States and will continue during the period of the Plan. We have in addition recommended certain measures to be taken up during the Plan period. With all this, however, the size of the conservation effort would remain very small. The survey would furnish basic data necessary for undertaking a larger and more comprehensive programme commensurate with the magnitude of the problem in subsequent years.

6. Most of you, being technicians, are concerned with the technical side of the erosion problem. The technical aspects of soil conservation are very important and I think a great deal of technological advance and development of new techniques to suit the problems of the Indian cultivators are necessary before soil conservation can be practised on a large scale in this country. The basic techniques of soil conservation construction of bunds and terraces to check the flow of rain-water down the slopes, planting cover crops, etc. – are simple and very old. One has only to look at the beautifully terraced fields along the hill sides in many parts of our own country, and in Java, Philippines and other countries of Asia, to appreciate the levels to which these techniques had been developed long ago by the peasants with manual labour alone. These terraces have been built through generations of patient work and maintained with consistant vigilance. In recent years, however, technological advances have greatly increased the scope of soil conservation work, and what was possible only in a few favoured localities before can now be adopted over large areas. The development of tractors and heavy earth moving machinery in particular, have made it possible to construct bunds, terraces, check-dams, etc., in a very short time and at much lower cost than was possible earlier. Eroded fields can be levelled and ploughed and suitable embankments constructed to prevent further erosion in a few hours, where it took weeks of laborious work before. These mechanical methods are used extensively in the U.S.A., Canada and other western countries.

They have their place in India also, as we have seen in the case of reclamation of kans-infested waste lands. But their applicability in this country is limited. It is for you, technicians of this country, to perfect techniques which are suitable for the small holdings and limited resources of the Indian cultivators. Only then can erosion control and soil conservation measures be adopted over large areas. This is a challenge which the technicians must take up. To develop research in soil conservation problems, we have recommended in the Planning Commission Report the establishment of a chain of research and demonstration centres each located in a selected area of extensive soil erosion. These research stations are intended to evolve techniques suitable for local conditions, and also to serve as bases from which these techniques can be propagated among the cultivators.

7. The social aspects of soil conservation are, I think, even more important than the technical aspects. Soil conservation is a social problem in a very real sense. Erosion is caused after all by man's misuse of land. It is his needs for timber, fuel, fodder or for cultivable land which lead to the destruction of forests and grasslands and to soil erosion. Conservation measures must necessarily impose restrictions on land use by certain sections of the population. These restrictions can be really successful only if the people concerned understand their need and value. For the protection of forests on hill slopes, for example, it is necessary to restrict grazing and felling. These restrictions are necessary in the larger interests of the community – the welfare of the entire population of the plains depends upon the preservation of these forests and must be strictly enforced even though they may cause some loss to graziers and other people living in the forests. Enforcement of these restrictions by law is necessary and has its place. But enforcement would be most successful and the forests would be best preserved, if the local populations realize that such restrictions are absolutely essential for the life and prosperity of countless millions in the plains who depend upon the protection (from floods, etc.) afforded by these forests. Of course, suitable arrangements must also be made along with the restrictions for providing alternative employment to the populations whose means of livelihood would be affected. A plan for soil conservation in forest areas must, therefore, make provision not only for enforcement of the necessary restrictions on usage, but also for educating the local populations in the need for these restrictions and for rehabilitation of those who would be adversely affected.

8. Similarly, for soil conservation work on cultivated lands, education of cultivators is necessary. The cultivators must (i) be convinced of the need for these conservation, (ii) know what part they have to play in the conservation programme, and (iii) understand the significance of the various measures which are being advocated. These three things are absolutely essential, because a large part of the soil conservation work has to be done by the cultivators themselves, and for the remainder also we need their co-operation. Improvements in farming practices like contour ploughing, growing of cover crops, strip cropping, proper crop rotations depend entirely upon cultivators. Government can only demonstrate the correct methods or at best encourage their adoption by giving certain supplies (like seeds and fertilizers) at subsidized rates. Construction of bunds, terraces, check-dams, etc., may be done by the Government or by the cultivators. But whoever construct them, and however, the costs are shared between the cultivators and the Government, maintenance depends upon the cultivators. These bunds and terraces cannot perform the functions for which they are intended until the cultivators realize their importance and maintain them in proper condition.

9. It is perhaps not always difficult to convince the cultivators of the need for conservation. But it is generally difficult to get them to participate in soil conservation programmes because these involve changes in age-old agricultural practices, and restrictions on land use, which may mean foregoing immediate gain. Besides, considerable effort and expenditure on improvements are also involved. Experience in the U.S.A. and other countries has demonstrated, however, that 'it can be done'. Individual farmers will see beyond their immediate

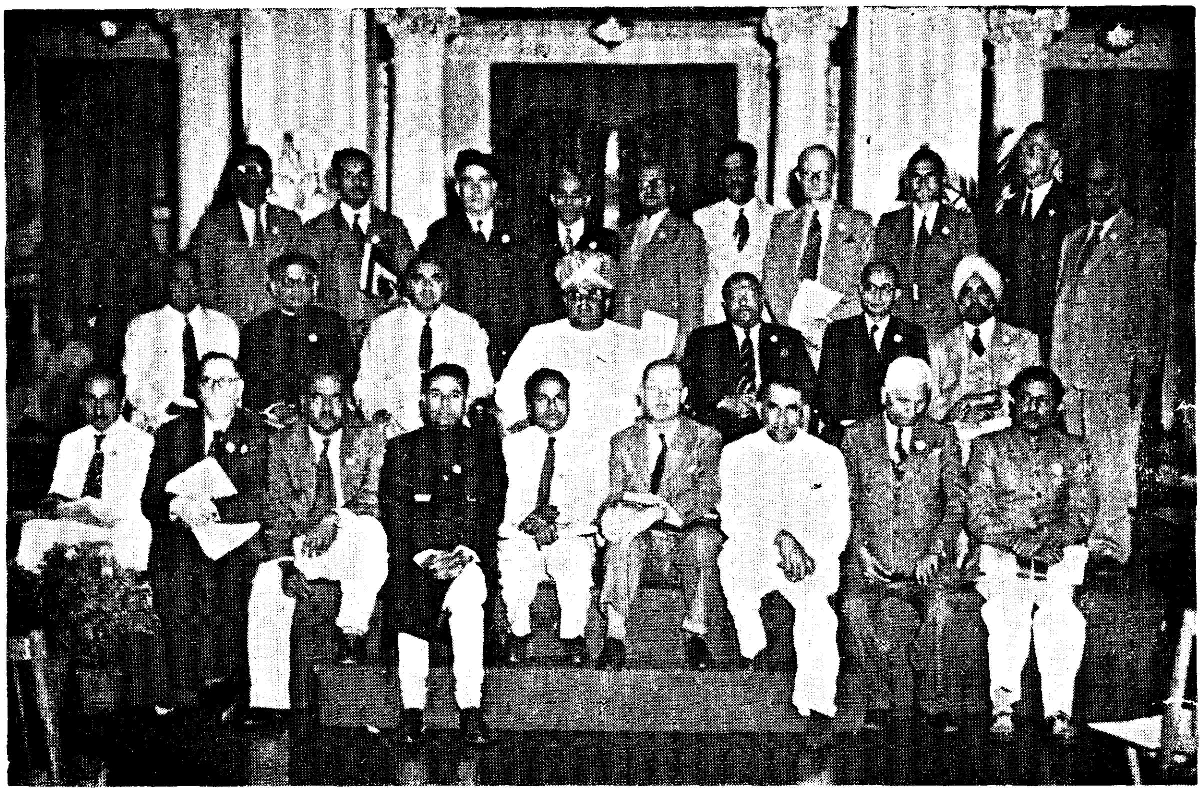
short-term interest to the need of the coming generations and the nation as a whole, will impose restrictions on themselves and will incur expenditure on improvement measures, if a proper approach is made to them. In a country like India the job is more difficult than in the U.S.A. and other countries. Because of the high pressure of population on land, holdings are very small and agricultural incomes very low. The cultivators generally try to get as much out of the land as possible. The margin for voluntary restrictions, as well as for making investment on improvements is, therefore, small. Still, if the cultivator is convinced that soil conservation is necessary in his own long term interest, and for the prosperity of the coming generations, and is told what he has to do in a language which he understands, his co-operation will be forth-coming.

10. There is one other aspect of soil conservation work to which I should like to refer. Soil conservation work by its nature requires the co-operative effect of experts from different fields. This fact is demonstrated, perhaps as well by anything else, as by the composition of your own society. Its membership is composed of foresters, engineers, soil scientists, agronomists, geographers, geologists, economists and other social scientists. This coming together of different types of specialists indicates not only their interest in soil conservation but also the fact that each group has its own distinctive contribution to make to soil conservation work. This need for co-operation from different fields brings with it, however, certain administrative and organizational problems. There is, for instance, the question of the most suitable form of organization for formulation and execution of soil conservation programmes. Soil conservation work in the different States has been done so far by either the Agriculture or the Forest Departments. But clearly soil conservation is not the concern of these two Departments alone, even though the major part of execution of soil conservation programmes may have to be done by them. Other Departments, especially the Revenue and the water resources development (Irrigation and Hydro-electricity) Departments are directly concerned, and should participate at least in the formulation of soil conservation programmes. The need for association of the water resource development Departments with soil conservation work is obvious. Soil conservation in the catchments must form an integral part of work on all major irrigation and hydro-electric projects because all these projects involve construction of dams and reservoirs which will be silted up quickly and will always remain, subject to damage from sudden and violent floods if proper erosion control measures are not taken. In order to secure the co-operation of the various Departments concerned, we have recommended in the Planning Commission Report, the constitution, at both the Central and State Government levels, of Land Utilization and Soil Conservation Boards consisting of representatives from the various Departments (Ministries in the case of the Central Government) concerned. The policies and programmes will be formulated by these Boards which can then be broken up into parts for execution by the different Departments concerned. The precise patterns of allocation of work and administrative procedures will undoubtedly have to be adjusted and modified to suit local conditions. But the association of representatives from the different Departments will enable these Boards to adopt a co-ordinated approach and to draw up well balanced and comprehensive programmes which are not limited by narrow Departmental considerations.

11. Whether in the course of this century, India becomes a desert or a land flowing with milk and honey will depend on the beginning that you will make, the inspiration you will give and the practical measures that you will help in promoting with informed public co-operation. I wish your deliberations every success. Time is already running against us and we must not fail. Here more than anywhere else nothing succeeds like success and fails like failure.

CENTRAL BOARD FOR WILD-LIFE

Delegates to the Inaugural Session, Mysore, November 25, 1952



Standing—Messrs. J. N. Sinha, B. V. Ramanjulu, M. D. Chaturvedi, D. Rai, M. S. Krishnan, S. Venkateswaran, R. C. Morris, R. P. Sharma, D. Van Ingen, B. J. Singh.

Sitting—Messrs. N. Pal, M. K. Unni Nayar, Dharmakumarsinhji, H.H. the Maharaja, K. P. Biswas, S. C. Law, J. A. Singh.

Sitting front row—Messrs. H. A. Ali, S. L. Hora, N. D. Sahni, D. C. Kaith, Mari Gowda, E. P. Gee, M. A. Muthanna, S. D. Udhrain, Raja of Sandur.

Dr. Punjabrao Deshmukh, the Union Minister for Agriculture, addressing the delegates at the Plenary Session of the Central Board for Wild-Life.

THE MYSORE WILD-LIFE CONFERENCE

BY B. J. SINGH, I.F.S.

Deputy Inspector-General of Forests, Delhi

The inaugural session of the Central Board for Wild-Life recently constituted by the Government of India was held at Mysore from November 25 to December 1, 1952. This was a happy augury for the dumb denizens of our forests which have steadily declined in numbers, helpless, as they are, against the reckless improvidence of man who is armed to-day with modern weapons of destruction.

The delegates to the Conference were nominated by the Central and State Governments and included sportsmen of repute noted for their sympathy for the preservation of Wild-Life. Among these were Colonel Burton, I.A. (Retd.) of Bangalore, Messrs. Randolph Morris of Mysore, A. P. Gee of Assam, Maharajakumar Dharmakumar Singhji of Bhavnagar, Shri Humayun Abdul Ali of the Bombay Natural History Society, and Shri M. D. Chaturvedi, the Inspector-General of Forests.

Shri M. D. Chaturvedi to whose untiring efforts the Board owes its inception, while initiating the proceedings of the first day of the session and inviting the Chairman of the Board, His Highness the Maharaja and Rajpramukh of Mysore to inaugurate the session, briefly narrated the need for, and the circumstances under which this Board had come to be established. He stated :—

> "In the wild-life of India, we have, a national heritage of which we may be justly proud. It is an asset which we may not lightly permit to be frittered away in our own interest. For nature, is in balance, the least little disturbance of which is likely to rebound on human habitations. The visitation of hyaenas and wolves in Lucknow and Agra which hit the head-lines not very long ago, illustrates *par excellence*, the consequences of the whole-sale destruction of game which forced the animals to turn to human habitations".

He added that in 1935, an All-India Conference had examined the question of protection of wild-life and had made certain recommendations. More recently, attention had come to be drawn to this problem in 1948–49 in a pamphlet brought out by Lt.-Col. Burton under the auspices of the Bombay Natural History Society. Shri Chaturvedi went on to inform the Board that the Government of India had appointed an *ad hoc* Committee to consider ways and means for the preservation of Wild-Life in 1951, on the recommendation of which the present Board had been set up under the distinguished Chairmanship of His Highness the Maharaja and the Rajpramukh of Mysore whose interest in wild-life had found concrete shape in the Bandipur and the Chamarajnagar sanctuaries. Shri Chaturvedi added that, in His Highness, the dumb denizens of the Forests had at last found a champion worthy of the cause.

In his inaugural address, the Rajpramukh observed that formerly, Kings and Rulers were responsible for maintaining large tracts of forests where many of the wild animals were preserved for sport. But conditions had since changed, and the protection once afforded to these animals, was no longer available to them, with the result that many of the finest specimens had nearly reached the verge of extinction ; some had already become extinct. The management of wild-life, he added, envisaged not only its preservation, but also its control, not excluding the destruction of certain predators such as wild dogs, wild pigs, etc. The Rajpramukh drew particular attention to the fact that natural forest cover providing shelter for game was fast disappearing under the stress of an ever increasing population, and dwelt on the vital link which existed between the animal and plant life. Dimunition of natural

resources was particularly evident in India and other Eastern countries where wants of vastly increased population had been met by uncontrolled and unwise encroachment on natural resources.

Referring to the relations between animal and plant life, the address said, there was a strong link between the two and they were far more intimate than ordinarily imagined. Plants greatly influenced natural animal population. The total extinction of certain forms of plant and animal life might be traced to the disturbance of equilibrium by human agency. As the results of the abuse of natural resources take a long time to reveal themselves and as natural recuperative forces are likewise slow in their operation, any plan and programme for protection of Nature, and conservation of natural resources will have necessarily to be based on a long range policy well above the whims and fancies of party politics. It had to be handled on a National rather than a local footing.

So the watchword should be to stop quickly the ruthless slaughter of wild-life by irresponsible people.

While quoting in the language of the Vedas, the Chairman concluded by saying :—

> "I have stated some of the urgent problems facing us for your consideration and I sincerely hope that it will be possible for us, during the course of our present session, to tackle at least some of the basic questions and be in a position to offer constructive suggestions to the Government of India".

The delegates divided themselves into four committees with specific terms of reference which covered almost every conceivable angle of the problem from legislation in and outside Reserved Forests and its enforcement to the widely prevalent destruction of wild-life that is going on through such practices as shooting from motor cars at night, from poaching and sale of meat, to the trapping of birds at all times ; from the creation of National Parks and sanctuaries to the problem of educating the public through zoological parks, the press, screen and the radio.

The recommendations of each Committee were correlated at the plenary session of the Board presided over by the Chairman, H.H. the Rajpramukh. Among the recommendations made by the Board, attention needs to be specifically drawn to the proposal declaring certain species, on the verge of extinction, as protected animals. In view of the danger attendant upon the concentration of the Indian Lion in a single locality, viz., the Gir forest in Saurashtra, the Board felt that it was advisable to develop another centre for this vanishing asset of wild-life. There could be nothing so unwise as to have all one's eggs in one basket. The Board also adopted a resolution changing its name from "Central Board for Wild-Life" to "Indian Board for Wild-Life", so as to specify its precise territorial limits for international purposes. That the protection of wild-life particularly those threatened with extinction are matters of urgent national importance was further emphasized by another recommendation, that it be declared by Parliament by Law to be an institution of national importance as envisaged in items 62 and 64 of List I – Union List – of VII Schedule of the Constitution.

The plenary session of the Board was wound up by Dr. Panjabrao Deshmukh, the Union Minister for Agriculture, who, *inter alia*, stated in his address :

> "In our wild-life we have a precious heritage which we must look upon as a sacred trust to be handed over to the generation to come".

Appreciating the need for the protection of species threatened with extinction, Dr. Deshmukh observed :—

> "I note with gratification the stress laid by you on the urgent need for providing protection to some of our animals whom our improvidence has driven to the

verge of extinction. The preservation of the rhinoceros of Assam, the wild ass of Saurashtra, the *cheetah* of Central India, and above all, the Indian Lion should be assigned special priority. I am informed that the lion which once covered the entire North-Western region has now receded into one and only pocket which the Gir forest in the Kathiawar peninsula provides. I am glad to note that the Board has drawn attention to the need for nursing up lions in another suitable centre".

Shri Deshmukh very rightly pointed out :—

"It will not do to rely only on legislation in a matter like this. What is of utmost importance is to arouse the public conscience against the insensate killing of our beautiful birds and animals who cannot defend themselves against the modern weapons of destruction and the insatiable greed of man. We must create an atmosphere which will convert a poacher into a preacher for the preservation of wild-life, and inculcate a spirit of true sportsmanship among our people".

On the concluding day, Shri Chaturvedi dwelt on the strange paradox of the sportsman championing the cause of wild-life. He said :—

"TO-DAY is a red letter day, not only for our birds and animals, but also for the naturalist and the sportsman. It is a peculiar paradox of life that is so puzzling to the human mind that the man who destroys wild-life should be the man who loves it most. Everyone kills the thing he loves : the proud by possession, the biologist with a Latin name, the poet by faint praise, and the sportsman with a gun. There are only two major tragedies in the life of a sportsman ; one not getting his trophy and the other more serious one, getting it. There is nothing so disheartening as not getting the tiger you are after and yet there is nothing so heart-breaking as when you have shot and got your tiger, when the handsomest of animals lies dead at your feet. It is only in this strange contradiction of the *shikaries* of India, and the *safaris* of Africa that wild-life has its craziest support.

"In the setting up of the Central Board of Wild-Life, I find the realization of what has been a dream to me for the best part of 30 years which I have spent in the forests in the closest association with the gorgeous wild-life they support. I have no doubt, Sir, everyone present here would voice the same sentiments. To Col. Burton, the doyen of Wild-Life in India, it must be a matter of great satisfaction indeed, that his labours have at long last begun to yield results. I understand he is going home, and I take this opportunity of expressing our gratitude for all that he has done in furthering the cause so dear to our hearts.

"In Your Highness, Sir, the voiceless denizens of the forest have found a staunch champion, and the sportsman of India their best exponent. The number of bisons *chital*, elephants and *sambhar* we saw in the Bandipur sanctuary provide an eloquent testimony of the interest of Your Highness in wild-life. Indeed, at one place we saw a herd of bison which excelled the scrambling herd of their admirers. A measure of the interest His Highness took in the proceedings of this Conference is provided by the exhaustive address he delivered on the opening day of the Conference. There is no recommendation of the Board which has not been carefully examined by him.

"On behalf of the Board and on behalf of the proud peacock and the colourful pheasant, the noble lion and the royal tiger, the mighty buffalo and the vanishing rhino, the stately elephant and the sleek deer, and on behalf of other birds and animals who prefer to be nameless on this occasion, I would like to express the feelings of gratitude for the signal honour, Dr. Deshmukh, the Union Minister of Agriculture, has done by gracing this occasion. As a token of their affection, the bisons

of Bandipur have sent one of their stockings which His Highness, Our Chairman, has directed me to present to you with the hope that this light would act as a beacon light for the cause so dear to us.

"I would be failing in my duty if I did not express our grateful appreciation of the unstinted hospitality and unbounded generosity of H.H. the Maharaja and the Rajpramukh of Mysore. To the Government of Mysore, and in particular to the Chief Conservator of Forests and his staff our thanks are due for the splendid arrangements made for holding the session.

"To the members of the Board I take this opportunity of expressing my gratitude in my personal capacity for the earnestness which they brought to bear on the tasks assigned to them. True there were differences of opinion in the Committee meetings, but they served to illumine our path and revealed what would otherwise have remained concealed. I may, however, strike here a note of warning. Organizations of this nature are apt to lapse into inanition due to sheer lack of interest, as the Honourable Minister remarked yesterday, by a plethora of rules, regulations and bye-laws. I would like to convey the advice of Dr. Deshmukh to the Executive Committee, to cut clean through red-tape and have only one rule of business, viz., business first. I express the hope that this Board, under the able guidance of His Highness, will grow from strength to strength".

The Central Board of Wild-Life has given a lead to the country. There is no doubt that the States will now take up the matter in hand and set up State Boards on the pattern of the constitution of the Central Board. Among the other recommendations of the Board, specific mention is made regarding the creation of :—

(1) National Parks dedicated for all time to conserve the scenery and natural and historical objects of national significance and wild-life therein, and to provide for the enjoyment of the same and leave them unimpaired for the future generations ;

(2) Wild-Life Sanctuaries (or Wild-Life Refuges) of such size and in such numbers which the needs of the preservation of wild-life more particularly of the species which have become scarce or which are threatened with extinction, may demand ; and

(3) Zoological Parks for the purposes of entertainment, recreation and study of animal life and providing ideal conditions for rescuing and multiplying any species on the verge of extinction. These parks are different from zoological gardens in as they provide space and secure conditions similar to those in natural habitats for the housing of animals.

Above all, the need of the hour is to arouse public conscience against the insensate and thoughtless killing of our beautiful birds and animals which is indulged in from profit motive. The revolting practice of the netting of birds followed by untold cruelty involved in their transport to the centres of consumption can only be stopped effectively if the public opinion is stirred up in a manner rendering the sale of such birds impossible. Nothing encourages a poacher in his nefarious activities so much as being able to get a fancy price for venison he can offer for sale. As long as partridges appear on the menus of fashionable restaurants and people can ply a lucrative trade in quails and venison, there is little hope for these hapless creatures.

The Resolutions adopted by the Central Board for Wild-Life at its first session held in Mysore are reproduced below :—

RESOLUTIONS ADOPTED BY THE CENTRAL BOARD FOR WILD-LIFE AT ITS FIRST SESSION HELD IN MYSORE FROM THE 25TH NOVEMBER TO THE 1ST DECEMBER, 1952

Name. 1. THE CENTRAL BOARD FOR WILD-LIFE RECOMMENDS :

that its name be changed to "INDIAN BOARD FOR WILD-LIFE", so as to specify its precise territorial limits for international purpose.

Declaration of the Central Board for Wild-Life as an institution of national importance.

2. WHEREAS India's heritage of wild-life is fast becoming a vanishing asset in respect of some of the country's notable animals, such as, lion, rhinoceros, tragopan, *cheetah*, etc.

WHEREAS the preservation of the fauna of India and the prevention of the extinction of any species is a matter of great national importance, and

WHEREAS protection in balance with natural and human environment are also matters of urgent national importance,

THE CENTRAL BOARD FOR WILD-LIFE :

RECOMMENDS to the Government of India that, despite the existence of entry 20 "Protection of wild animals and birds" in List II (State List) of the seventh Schedule to the Constitution of India, the Central Board for Wild-Life, with the marginally noted functions assigned to it under the Ministry of Food and Agriculture Resolution F. 7-110/51-R of the 4th April, 1952, be declared by Parliament by Law to be an *institution* of *national importance* as envisaged in item 62 and 64 of List I – Union List – of the VII Schedule to the Constitution more specially as the proper exercise of the functions of the Board will involve recourse to action under one or more of the following entries in the Union and concurrent Legislative Lists :—

(i) To devise ways and means for the conservation and control of wild-life through co-ordinated legislative and practical measures, with particular reference to seasonal and regional closures and declaration of certain species of animals as 'protected' animals and prevention of indiscriminate killing;

(ii) to sponsor the setting up of national parks, sanctuaries and zoological gardens ;

(iii) to promote public interest in wild-life and the need for its preservation in harmony with natural and human environment ;

(iv) to advise Government on policy in respect of export of living animals, trophies, skins, furs, feathers and other wild-life products ;

(v) to prevent cruelty to birds and beasts caught alive with or without injury ; and

(vi) to perform such other functions as are germane to the purpose for which the Board has been constituted.

List I—item (Union List)	5.	*Arms, fire-arms, ammunition and explosives.*
,, ,,	13.	Participation in the international conferences associations and other bodies and implementing of decisions made thereat, e.g., the International Union for the Protection of Nature.
,, ,,	41.	Trade and commerce with foreign countries ; import and export across customs frontiers in so far as living animals, trophies, skins, furs, feathers and other wild-life products are concerned.
,, ,,	42.	Inter-State Trade and Commerce with respect to matters specified against the preceding entry (No. 41).
,, ,,	81.	Inter-State migration (of wild-life).

List III—item 17. Prevention of cruelty to animals.
(Concurrent List)

" " 29. Prevention of the extension from one State to another of infectious or contagious diseases or pests affecting men, animals or plants.

" " 33. Trade and Commerce in and the production, supply and distribution of the products of industries where the control of such industries by the Union is declared by Parliament by law to be expedient in the public interest.

[Sub-Section (2) of Article 246 enables Parliament to make laws with reference to any of the matters enumerated in List III].

Amendment of the constitution of the Central Board for Wild-Life.

3. WHEREAS the Constitution of the Central Board for Wild-Life set up by the Government of India requires elaboration and amplification with a view to devising ways and means for the proper fulfilment of its aims and objects,

THE CENTRAL BOARD FOR WILD-LIFE RECOMMENDS :

(*a*) that each State Government should be requested to set up a State Wild-life Board consisting of representatives of various organizations and interests to deal with the day-to-day administration of local Wild-Life problems.

Note.—The co-ordination of the activities of the State Boards will be effected through the Central Board for Wild-Life.

(*b*) that Honorary Regional Secretaries should be appointed as the Board's representatives to cover on its behalf the various regions in India.

Note.—Appointments of Honorary Regional Secretaries will be made by the Government of India and duly notified in the Gazette of India. Each Regional Secretary will maintain liaison between the Central Board and the State Boards. It will be necessary to make provision for the travelling allowance of the Regional Secretaries for the journeys performed by them in their respective regions in the discharge of their duties assigned to them by the Board.

(*c*) that Dr. S. L. Hora, Director, Zoological Survey of India and President, National Institute of Sciences, India, should be appointed as the Honorary Secretary-General of the Board.

(*d*) that for the day-to-day administration, an Executive Committee consisting of the following be constituted :—

The Non-official Vice-Chairman .. .. (*Chairman*).
The Regional Secretaries.
The Secretary-General.
The Secretary of the Central Board .. .. (*Secretary*).

Note.—The Executive Committee will be vested by the Board with authority to function on its behalf in the disposal of day-to-day business.

(*e*) that the Constitution of the Board should be so amended as to cover the above recommendations.

Executive Committee.

4. WHEREAS it is necessary to provide the Executive Committee of the Board with authority to carry on the day-to-day business of the Board and to take action on its behalf while the Board is not in session,

THE CENTRAL BOARD FOR WILD-LIFE RESOLVES :

(*a*) that the Executive Committee be vested with full powers to take necessary action in pursuance of the objects of the Board, to deal with the day-to-day business of the Board and to address the Central Government and other authorites on various matters concerning the business of the Board ;

(*b*) that the Executive Committee will transact its business by circulation as far as possible and will meet at least once in 6 months ;

(*c*) that the Executive Committee will frame bye-laws for the disposal of its own business as well as the business of the Board subject to the ratification of the Board ;

(*d*) that the proceedings of the Executive Committee shall be circulated to the Members of the Board in the form of periodical bulletins ;

(*e*) that in the event of a decision to be taken in respect of a State, the representative of the State concerned on the Board shall be co-opted ; and

(*f*) that the Executive Committee be authorized to make verbal alterations in the language of the resolutions to be presented to Government.

5. THE CENTRAL BOARD FOR WILD-LIFE RESOLVES :

Thanks to Mysore Government.

that its grateful appreciation of the generous arrangements made for holding its inaugural session at Mysore should be conveyed to the Government of Mysore.

In particular, the Board would like to convey its gratitude to His Highness the Rajpramukh for his unstinted hospitality and for the interest he has taken in the proceedings of the session.

The Board also acknowledges with thanks the assistance rendered by the Chief Conservator of Forests, Mysore and his staff in organizing visits to various institutions and making arrangements for the delegates.

Protection of Nature and Wild-Life.

6. WHEREAS the preservation of Nature in its unspoiled state is deemed essential for its educative and aesthetic value ;

WHEREAS wild-life in India is progressively diminishing,

WHEREAS some of the wild animals have already become extinct or are on the verge of extinction,

AND WHEREAS the maintenance of an equilibrium between the vegetable kingdom and the animal kingdom and among the animals themselves is of importance to mankind,

THE CENTRAL BOARD FOR WILD-LIFE RECOMMENDS THAT THE ATTENTION OF THE STATE GOVERNMENTS SHOULD BE DRAWN TO THE NEED FOR

(*a*) the creation of National Parks in conformity with the general objectives laid down by the International Union for the Protection of Nature and affiliated bodies,

provided that should a State create a National Park, the advice of the Central Board for Wild-Life will be taken to ensure its national character.

Note.—The term 'National Park' for this purpose would generally denote an area dedicated by statute for all time, to conserve the scenery and natural and historical objects

of national significance, to conserve wild-life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpared for the enjoyment of future generations, with such modifications as local conditions may demand.

(*b*) the creation of Wild-Life Sanctuaries (or Wild-Life Refuges) of such size and in such numbers which the needs for the preservation of wild-life, more particularly of the species which have become scarce or which are threatened with extinction, may demand.

Note.—1. The expression 'Wild-Life Sanctuary' shall denote an area constituted by the competent authority in which killing, hunting, shooting or capturing of any species of bird or animal is prohibited except by or under the control of the highest authority in the department responsible for the management of the Sanctuary. The boundaries and character of such a sanctuary will be kept sacrosanct as far as possible. Such sanctuaries should be made accessible to visitors.

2. While the management of sanctuaries does not involve suspension or restriction of normal forest operations, it would be generally desirable to set apart an area of 1 to about 25 square miles within a sanctuary where such operations may not be carried out, to ensure the nursing up of wild-life undisturbed by human activities. Such sacrosanct areas may be declared as *Abhayaranya*, i.e., a forest where animals could roam about without fear of man. Such a sanctuary within a sanctuary would also ensure the preservation of plant life unspoiled and undisturbed.

3. In the management of sanctuaries, control should be exercised over elements adverse to the maintenance of wild-life, including destruction of vermin and predators. In the case of any difficulty, expert advice may be obtained from the Central Board for Wild-Life.

4. In the event of a sanctuary being located in one State contiguous to a sanctuary in another State, the desirable co-ordination may be effected through the Central Board for Wild-Life.

(*c*) imposing restrictions on the issue of shooting permits and by the prohibition of shooting in State Forests of a particular species for such periods as may be deemed necessary in order to attain the objectives in regard to the preservation of wild-life.

Note.—Special 'preservation plots' may be constituted where plants of medicinal value or species of special botanical interest may need to be preserved along with or without wild-life.

(*d*) encouraging members of the public interested in wild-life to assist in the preservation of wild-life by appointing them as Honorary Wild-Life Officers who will perform the duties and enjoy the powers and privileges of Forest Officers in respect of preservation of wild-life delegated to them.

Note.—All the members of the Central and the State Wild-Life Boards as well as Honorary Wild-Life Officers should be issued with a badge of Office and an identity card in consultation with the Central Board for Wild-Life.

(*e*) the setting up of zoological parks for the purpose of entertainment, recreation and study of animal life.

Note.—1. These parks should provide ideal conditions for rescuing and multiplying any species on the verge of extinction.

2. A Zoological Park is different from a zoological garden, inasmuch as it provides space and secures conditions similar to those in the natural habitats for the housing of animals, which are not possible in zoological gardens.

(*f*) modelling the administration of zoological gardens of the various States along the lines of Alipore Zoo, Calcutta.

Note.—The maintenance of zoos at a high standard of efficiency is desirable, and advice in this respect may be obtained from the Honorary Secretary-General of the Central Board for Wild-Life.

(*g*) declaring the following species as protected animals :—

(i) Indian Lion.
(ii) Snow Leopard.
(iii) Clouded Leopard.
(iv) Cheetah.
(v) Rhinoceros (all species).
(vi) The Indian Wild Ass.
(vii) Kashmir Stag.
(viii) Musk Deer.
(ix) Brow-antlered Deer.
(x) Pigmy Hog.
(xi) Great Indian Bustard.
(xii) Pink-headed Duck.
(xiii) White-winged Wood Duck.

Note.—This list is illustrative and not exhaustive and may have to be added to from time to time to suit local conditions. Legislation should be enacted where necessary to secure complete protection of these animals and birds which are on the verge of extinction.

Protection of the Lion.

7. WHEREAS the Indian lion, which not long ago was distributed throughout North-west India,

WHEREAS the Indian lion has now receded to the confines of Gir Forest in Kathiawar Peninsula, and

WHEREAS the Indian lion is an animal of national importance requiring rigorous protection,

THE CENTRAL BOARD FOR WILD-LIFE :

VIEWS with great alarm the dangers attendant upon concentrating the remnant lions in a single locality and not immune from epidemic and other unforeseen calamities ;

RECOMMENDS that an additional locality as a Sanctuary for the lions in a suitable area should be developed. In the selection of this locality, the original range and environment of the lion shall be taken into consideration,

AND REQUESTS that the attention of the Government of Saurashtra should be invited to the need for associating the Central Board for Wild-Life in the management of the lions of the Gir Forest.

Trading in Trophies, Skins, Furs, Feathers and Flesh.

8. WHEREAS unrestricted trading in trophies, skins, furs, feathers and flesh is detrimental to the wild-life resources of the country,

THE CENTRAL BOARD FOR WILD-LIFE RECOMMENDS :

(*a*) that the export of trophies as defined in the Bombay Protection of Wild Animals and Wild Birds Act 1951 (XXIV of 1951) should be prohibited except in cases which are covered by a *Certificate of Ownership* issued by the prescribed authority of the Central or State Governments such as Forest or Revenue Officers, etc., or whose ownership is otherwise established.

Note.—This provision will not apply to the re-export of trophies sent to India for finishing on the production of a certificate of the owner.

(*b*) that legislative control of internal trade in trophies should, for the present, await the experience to be gained in the Bombay State where legislation in this respect is being brought into force shortly.

(*c*) that, in the meanwhile, in order to discourage trading in trophies inside the country and to prohibit (*a*) the netting of birds and animals during 'close' periods, (*b*) their sale, (*c*) the sale of venison, (*d*) the sale of flesh and parts of other wild animals, the Government of India should invite the attention of the State Governments to the advisability of enforcing the provisions of Act VIII of 1912, as amended from time to time, or such other legislation as might have been enacted or extended for the purpose.

Prevention of cruelty to animals.

9. WHEREAS in the interests of wild-life, and for humane reasons, it is necessary to prevent cruelty to animals and birds during captivity and transit,

THE CENTRAL BOARD FOR WILD-LIFE RECOMMENDS :

that the co-operation of the Society for the Prevention of Cruelty to Animals (S.P.C.A.) should be sought in this connection and that Honorary Wild-Life Officers in every centre be requested to report all cases of cruelty to animals and birds in captivity and during transit.

Netting of wild brids and animals.

10. WHEREAS extensive netting of wild animals and birds is prejudicial to the maintenance of the balance of Nature and is detrimental to the wild-life of the country,

THE CENTRAL BOARD FOR WILD-LIFE RECOMMENDS :

that the netting of wild animals and birds should be stopped during 'close' seasons and that no exemptions should be permitted on the grounds of tribal or caste customs, livelihood, profession or usage.

Export and Import of living animals and birds.

11. WHEREAS the unrestricted export of living animals and birds tends to deplete the fauna of the country,

AND WHEREAS the unrestricted import of animals and birds is not in the interest of local fauna,

THE CENTRAL BOARD FOR WILD-LIFE RECOMMENDS :

(*a*) that the Chief Controller of Imports and Exports be requested to fix the annual limits for the *export* of each valuable species of wild-life to zoos, scientific institutions and circuses outside India on the recommendation of the Secretary-General of the Board,

(*b*) that all requests for *imports* of living specimens of wild-life by zoos, scientific institutions and circuses in India should be routed through the Honorary Secretary-General of the Board.

(*c*) that the *excise duty* to be levied on the export of animals for circuses should be double the duty levied on animals intended for bonafide zoos and scientific institutions,

provided that gifts and exchanges between bonafide zoos be exempt from such duties,

(*d*) that the State Governments be requested to give priority to the requirements of zoos in India in respect of species of wild-life over the requirements of foreign zoos,

provided that the restrictions contemplated in the aforesaid clauses shall not apply to exports of species classified as 'vermin'.

Note.—The phrase 'vermin' is defined in the Bombay Wild Animals and Wild Birds Protection Act (XXIV of 1951) as "any animal or bird specified in Schedule I and includes any animal or bird declared to be vermin under Section 18".

'Close' Season.

12. WHEREAS, owing to lack of uniformity in the periods prescribed by different State Governments as 'close' seasons, it is difficult for the Transport Authorities to keep a check on 'close' season offences.

THE CENTRAL BOARD FOR WILD-LIFE RECOMMENDS :

that movements of living birds be prohibited from 1st April to 30th September which, for all practical purposes, will be treated as 'close' season for purposes of transport.

Note.—This restriction will not apply to movements for bonafide purposes, e.g., exchange of specimens of Zoos and transport of birds by circuses, etc.

Compilation of statistics.

13. WHEREAS it is essential for the Central Board to maintain statistics of species of wild-life.

THE CENTRAL BOARD FOR WILD-LIFE RECOMMENDS :

that all State Governments be requested to furnish information on the following points to its Secretary-General :—

(*a*) Surplus species held by their zoos for disposal,

(*b*) species required by their zoos, and

(*c*) animals that can be captured in their Forests.

Symposiums.

14. WHEREAS it is necessary to focus attention on problems of educating the public on the value of wild-life.

AND WHEREAS zoos and national parks are institutions for such education.

THE CENTRAL BOARD FOR WILD-LIFE RECOMMENDS :

that symposiums should be held at an early date on the needs and requirements of

(*a*) Indian Zoos, and

(*b*) management of National Parks and Sanctuaries,

so as to assist in the formulation of policies in regard to the maintenance of wild-life exhibits in the zoos and the management of National Parks and Sanctuaries.

Co-operation of public in enforcement of measures for the protection of Wild-Life.

15. WHEREAS it is necessary to secure public co-operation in the enforcement of measures for the protection of wild-life.

THE CENTRAL BOARD FOR WILD-LIFE RECOMMENDS :

(*a*) that members of the public interested in Nature should be invited to become *Honorary Correspondents* to the Board in matters relating to wild-life ; and

(*b*) that members of the Board should be appointed as *Honorary Wild-Life Officers* on behalf of the Board in respect of the resolutions and recommendations passed and such instructions as may be issued from time to time by the Board.

Wild-Life Legislation.

16. WHEREAS it is necessary to preserve wild-life in the country as a whole,

WHEREAS the existing machinery for the protection of wild-life in areas outside the purview of the Indian Forest Act, XVI of 1927 or adaptations thereof, is inadequate, and

AND WHEREAS the protection afforded to wild-life in areas within the purview of the Indian Forest Act XVI of 1927, or adaptations thereof, requires strengthening.

THE CENTRAL BOARD FOR WILD-LIFE RECOMMENDS :

(*a*) that necessary legislation be enacted at an early date by the Centre or the States as the case may be.

Note.—The attention of State Governments is invited to the existing legislation for the protection of wild-life in various States and, in particular, to the 'Bombay Wild Birds and Wild Animals Protection Act, Act No. XXIV of 1951' and the Rules framed thereunder.

'Close' seasons, illicit shooting, etc.

17. WHEREAS there is reason to believe that there is need for the amendment of existing 'close' seasons observed in respect of birds and animals,

WHEREAS the list of animals and birds now treated as vermin needs re-examination with a view to limiting it to only those animals and birds which should be kept in check,

WHEREAS in some parts of the country there is wholesale destruction of wild-life with the help of dogs,

WHEREAS shooting from vehicles, with or without blinding spot, or head lights, shooting with torches, shooting over salt licks and water holes, destroying animals by using poisons, explosives and poisoned weapons, catching animals and birds by nets, traps, pits, snares, etc., and killing animals by driving them into snow or by fire require to be discouraged in the interests of the preservation of wild-life,

AND WHEREAS the use of buck-shot, wounds rather than kills animals.

THE CENTRAL BOARD FOR WILD-LIFE RECOMMENDS :

(*a*) that States do review, in consultation with the Central Board for Wild-Life, and, if possible with their contiguous States, their 'close' seasons for the various animals and birds to be protected,

(*b*) that States should re-examine their lists of 'vermin' from time to time to ensure that only harmful species are so classified, and

(*c*) that the attention of State Governments be invited to the urgent need for devising ways and means and of adopting such measures, including enactment of legislation, to discourage, if not to prohibit, these practices in the interests of wild-life.

Corp Protection Guns.

18. WHEREAS indiscriminate slaughter of wild-life is often indulged in with the aid of guns ostensibly held for crop protection.

THE CENTRAL BOARD FOR WILD-LIFE RECOMMENDS :

(*a*) that ways and means be devised to ensure that guns issued for crop protection are used only for the protection of standing crops and that the use of such guns for hunting or shooting should be prohibited unless the licensee secures such other licences as are prescribed,

(*b*) that the quantity and type of ammunition available to the holders of such guns should be restricted by the licensing authorities to such as is required for protection of crops only.

Note.—Licenses should be generally issued for single-barrel guns only.

Buffer Belts – around sanctuaries.

19. WHEREAS much destruction of wild-life goes on in areas contiguous to Sanctuaries, and

WHEREAS cattle-borne diseases are spread in such sanctuaries by domestic cattle from the surrounding areas.

THE CENTRAL BOARD FOR WILD-LIFE RECOMMENDS :

that buffer belts of sufficient width be declared around all sanctuaries within which no shooting, other that required for legitimate crop protection, will be permitted and within which no professional graziers will be allowed to establish their cattle-pens.

Inoculation against cattle-borne diseases.

20. WHEREAS many preventable cattle-borne diseases among herbivorous wild animals result from contact with infected domestic cattle in the neighbourhood of "forests".

THE CENTRAL BOARD FOR WILD-LIFE RECOMMENDS :

that State Governments be requested to inoculate systematically and periodically domestic cattle in the neighbourhood of national parks, sanctuaries and Reserves where and when necessary,

Publicity.

21. WHEREAS insufficient use is being made at present of the existing facilities of publicity afforded by the Press, Screen and Radio, for wild-life protection.

THE CENTRAL BOARD FOR WILD-LIFE RECOMMENDS :

(*a*) that adequate publicity material be issued from time to time by the respective Central and State Publicity Departments in close collaboration with Forest Departments and other organizations,

(*b*) that enthusiasts be approached to give publicity to wild-life,

(*c*) that documentary films dealing with various aspects of wild-life be produced by Governments in consultation with the Central or State Boards for Wild-Life for exhibition in both urban and rural areas,

(*d*) that amateur cinema-photography of wild-life be encouraged, and

(*e*) that the All-India Radio be requested to afford special facilities for wild-life broadcasts.

Education.

22. WHEREAS there is general lack of knowledge regarding conservation of nature and the value of wild-life, and

WHEREAS it is essential to educate public opinion in matters of wild-life.

THE CENTRAL BOARD FOR WILD-LIFE RECOMMENDS :

that special steps be taken to popularize wild-life by introducing stories in school text-books, by producing attractive charts, by organizing special lectures and through the establishment of zoos and Zoological parks in the neighbourhood of large cities.

Liaison.

23. WHEREAS for the purposes of education and publicity, co-ordination of such Departments as Forest, Agriculture, Horticulture, Scientific Research, Transportation (Tourist), and Information and Broadcasting is essential.

THE CENTRAL BOARD FOR WILD-LIFE RECOMMENDS :

that steps be taken through the Central and State Wild-Life Boards to co-ordinate the activities of all connected Departments in matters of management, publicity and education concerning wild-life.

SAMPLING AND ASSESSMENT OF NATURAL REGENERATION

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INTRODUCTION

Sampling of natural regeneration is just another sampling problem and has to be treated on the same general lines. In this country not much attention has been paid so far to determine appropriate techniques because assessment of natural regeneration has been mostly confined to small experimental plots and the need to apply and use it on a large scale has scarcely been felt. In recent years in the U.P., small indicator lines (containing from 500 to 1,000, 6 × 6 feet quadrats on either side of a generally straight line) have been laid out in one or two representative compartments of Selection working circles and PB II of Conversion to Uniform working circles in Dehra Dun, Lansdowne, Ramnagar, Haldwani, South Kheri, Bahraich and Gonda divisions with the object of keeping an eye on the progress of regeneration in such areas where no special measures are taken to induce appearance or growth of reproduction. So far ocular estimation was considered sufficient to determine whether the inflow or upsurge of regeneration was adequate in forests managed under selection fellings, but it appears desirable that the working plan officer should have something a little more definite to go upon. Of course, these necessarily small indicator lines do not and cannot yield satisfactory estimates for the whole area concerned but they provide a standard of judgement and the working plan officer can rate other areas on the basis of the compartment or portions of compartment sampled or covered by the indicator line. So far this work is of a tentative nature and the present paper deals with suitable methods for detailed assessment of regeneration in small experimental plots as well as rapid regeneration surveys over large areas. These methods are already being applied in research plots and during revision of working plans.

PART I

NATURAL REGENERATION EXPERIMENTS

2. *Sampling methods*—It would not be incorrect to say that so far the necessity of adequate sampling of regeneration has hardly been realized even in natural regeneration experiments where comparisons of far-reaching importance have to be made. Since proper designing of experiments is now receiving considerable attention, it is equally, perhaps more, essential to improve the systems of sampling and assessment, because whatever may be the result of the experiment, the conclusions necessarily depend for their validity on the method of collection and analysis of relevant statistics.

3. The following brief consideration of the method in use in U.P. shows its inadequacy :

The general practice is to lay-out one 12 feet wide indicator line (divided into 6 × 6 feet recording units) in each plot under a particular treatment combination. If it is contemplated to subdivide the plot at a later stage then two or more lines are laid out. Apart from this there is no guide with regard to the intensity of sampling, and size and dispersal of the sampling units. In fact it seems to have been assumed that one or two such lines would suffice regardless of the size of the plot. No investigation seems to have been carried out to determine the variability of stocking, proper shape and size of the sampling units, and the intensity of sampling adequate for the purpose. The low and inadequate intensity

of sampling resorted to is evident from the figures for some of the current *sal* regeneration experiments :

		Average area sub-plot acres	Average % sampling by 12 feet wide indicator lines
Old experiments			
Ramnagar 7	..	5·1	4·7
Pilibhit 7	..	5·2	2·8
New experiments			
Haldwani 23	..	0·9	7·6

4. The indicator line is a sort of transect, laid out approximately in the middle of the plot, more or less straight but with generally non-cumulative divergence of 30° to either side from station to station. The line is defined by what are known as "station trees". A convenient prominent tree is selected near the starting point and another convenient prominent tree is sighted in the general direction the line is to take as station number 2 and so on. The tendency is, therefore, to move from one exceptional tree to another and in plots where the distribution of trees and of dominants in particular is not homogeneous (it is rarely so) the indicator line generally follows a special and non-representative path. The kind and proportion of the canopy overlying the line is thus in general specially determined and so is the regeneration on the ground which is correlated with the canopy to a varying but usually significant extent.

5. All these factors operate to impart a unique character to the line and the probability is that the statistics collected from the line would be unrepresentative of the plot in the greater proportion of cases. Therefore, no valid ground exists for comparison of different plots under different treatments by indicator line data. The poor sampling achieved by such a line is illustrated below for an actual case in which the existing indicator line is compared with other sampling methods.

Sal natural regeneration experiment No. 23, Haldwani

Plot B 7. Area 0·9 acre (2 chs.×4·5 chs.) divided into 900 milacres (6·6 × 6·6 feet) assessment units. Indicator line, zigzagging through the plot, consists of 78 milacre quadrats on either side of the line, i.e., a sampling intensity of 8·7%. (In this case, a new experiment, the line has been made to zigzag through the plot rather than run straight, in order to increase the sampling %).

U = Unestablished regeneration

R = Current year's seedling (recruitment)

Deviation as % of actual mean

Character	Indicator line	Systematic by diagonals	Systematic central sample		Stratified random sample	
			Rows	Columns	1st series	2nd series
Sampling %	8·7	9·8	8·9%	10%	10%	10%
U per acre ..	+58·8	+33 8	−16·5	− 2·5	− 0·4	− 0·4
R per acre ..	+37·3	−40 9	+17·3	+58·1	+ 8·1	−20·8
U+R per acre ..	+53·6	+15·6	− 8·1	+12·6	+ 1·7	− 5·4
% Sample area with crown cover						
Free crown cover ..	−39·1	+ 8·6	+ 8·8	+13·8	− 6·2	+14·0
Overlapping crown cover	−91·8	−30·6	−71·4	+ 4·1	+14·3	0
Total crown cover ..	−43·7	+ 5·2	+ 1·8	+13·0	− 4·4	+12·8

6. Because of its general course from one big tree to another the line has run more through open spaces, where in general more regeneration occurs in this case. This results in a consistant overestimation of regeneration and equally regular underestimation of the proportion of canopy included in the sample. This regularity does not occur in any of the other samples of comparable intensity and clearly reflects the biassed character of the indicator line data. The figures also show that in general all other samples give better estimates of regeneration than the indicator line. It is, therefore, evident that instead of placing reliance on arbitrary methods, the whole question must be reviewed and starting from fundamental considerations a suitable method of sampling evolved so that comparisons of treatment means by the analysis of variance and covariance may be valid.

7. It is of course evident that adequate sampling could be done only in two possible ways, either two-dimensional by systematic or randomized quadrats as sampling units (each sampling unit may consist of a number of recording units) or one-dimensional by randomized or systematic strips as sampling units (the component quadrats being treated as recording unit only). It is necessary to determine the size of the sampling unit, taking all operational and informational factors into account. But the smallest sampling unit need not be the smallest recording unit (to be used as a unit for assessment) and for ease in computation, etc., it is preferable to fix the size of the unit of assessment more or less independently of the ultimate sampling units to be used.

8. A recording unit of $6 \cdot 6 \times 6 \cdot 6$ feet or the milacre quadrat is a very suitable recording unit for a number of reasons. It is known from experience that it is a convenient size for field work, not too large to introduce serious errors of omission and not too small to involve a great deal of demarcation with incommensurate advantages. It has the further important advantage of being decimally related to the acre and this is a great computational convenience. In current practice in India 6×6 feet assessment units are usual, but the milacre quadrat is preferable because per acre figures can be derived directly.

9. Strip or transect sampling, in fact a 'better' indicator line, would appear to offer the usual advantages of ease of demarcation and convenience of recording. The strips may be systematically or randomly located but in view of the general superiority of systematic over random sampling (in absence of periodicity trends and strip effects, even though a valid estimate of error cannot be derived) and the simplicity of systematic patterns, the latter may be preferred. The variant of systematic sampling in which the diagonals are taken as sampling units has some special advantage in certain cases.

10. It is also possible to do stratified random sampling in such a way that two primary units (in this case quadrats or twice or four times the quadrats, etc.) are selected from each block. If it is not required to calculate the precision of the estimate, then only one unit need be selected out of each stratum and this would give a better estimate still. In view of the technique of assessment discussed later which is based on the milacre quadrat as the primary unit, it has not been considered necessary to investigate the effect of the sampling unit size on the degree of sampling necessary for a given precision and it is assumed that the milacre quadrat would be used as the sampling unit. Twice the size could also be used to reduce the demarcation work. Even with this size the general accuracy should be expected to be greater than with strip sampling though the two random 10% sampling series actually considered in this paper do not markedly differ from comparable systematic strip samples in the accuracy and reliability of mean values.

11. With small plots of the order of 1 acre or so, 20% sampling would require location of 200 plots. After the strata corners have been marked by pegs, one sampling unit per stratum could be selected at random from a sketch map and a serial list and located on the ground roughly by stepping the distance. Greater accuracy is not required. If now a circular

milacre plot is laid out, it would eliminate any possible bias due to orientation. Taking a steel chain of the required radius (3 feet 7 inches approx.) provided with a steel peg at one end to fix it firmly in the ground and a marker at the other end, the plot can be easily traced on the ground. However, the method is troublesome and is not recommended unless specially accurate estimates are required.

12. From available statistics (which are admittedly very meagre) it appears that about 20% sampling is adequate for assessment of regeneration in *sal* experimental plots of about an acre size. It may be assumed that about 10% would suffice for a plot of about 5 acres. Such large plots are, however, now unusual in current research.

13. The sampling patterns considered below are based on systematic strip sampling techniques with milacre recording units and are primarily advocated for *sal*. They may be applicable to other pure gregarious species also but the appropriate intensity for mixed forest types has to be determined for each case.

A. Diagonal sampling patterns may be preferable in specific cases :

(i) *Diagonal systematic sampling*—It is recommended for squarish plots of about an acre size. If the two diagonals are two quadrats wide, the sampling % is $2\sqrt{2} \cdot \frac{100 \times 13 \cdot 2}{a}$ (ignoring the small central overlap and unsampled corners) where 'a' is the side of the square in feet, i.e., approx. 20% sampling for a 0·8 acre plot. This arrangement is particularly suitable for cases in which plots occur side by side with no or small 'buffer' zones and particularly with treatments (e.g., canopy variation) which may have pronounced marginal effects. In such circumstances the central portion of the plot may be considered more representative of the treatment. 20% overall diagonal sampling will then provide for a 40% sampling of the central quarter of the plot and, therefore, the contribution of the central portion to the full sample would be greater than that of the peripheries. Half of the sample would be confined to this central quarter, the rest, i.e., $\frac{3}{4}$ area being covered by the remaining half of the sample. The central quarter could be specially marked by pegs and the quadrats falling in this portion numbered in a separate series to facilitate comparison between plots on the basis of the central quarters alone. The chief disadvantage is that only two sampling units are used but as sampling errors would not always be calculated, this may not be serious.

(ii) *Multiple diagonal systematic sampling*—It is recommended for split-plot experiments where the main plots may be subdivided at a later stage. It is suitable for main plot sizes of the order of four acres.

The main plot is divided into the contemplated sub-plots and diagonals of each connected. For a four acre square main plot to be split up into four sub-plots, approximately 20% sampling of one acre sub-plots would be achieved by two quadrat wide sub-plot diagonals.

If the above main plot is divided into two portions only, each will be sampled to the same intensity, i.e., approx. 20%. Similarly the central quarter is sampled to this intensity. The advantages and disadvantages are the same as for design (i).

B. Strip sampling can be adjusted to sample the area to any desired intensity :

(i) Two-dimensional systematic strip sampling by centrally located 6·6 feet wide strips, running at right angles to each other. This arrangement is suitable for squarish plots.

(ii) Centrally located systematic 6·6 feet wide strip samples—strips running parallel to shorter size unless there is a pronounced fertility gradient. If there is a fertility gradient the strips should run along it. This pattern is preferable for oblong plots.

14. *Assessment of regeneration*—Taking a milacre quadrat (6·6 × 6·6 feet if square ; but it may be of any convenient shape, e.g., circular) as a recording unit, the method of assessment is discussed below. This is with particular reference to *sal* (*Shorea robusta*) and in general as applicable to more or less pure forests with one economically valuable species.

(i) The milacre quadrat is considered completely stocked if it contains one established seedling (E) (to be defined for each particular case) giving an overall stocking of 1,000 plants per acre.

(ii) In absence of established plants, four unestablished seedlings (U) (all seedlings other than recruitment, which have not become established) are taken to be equivalent to one established seedling in the sense that ultimately on an average one out of these four may be expected to grow up to establishment size and thus four seedlings per quadrat may be considered sufficient guarantee for one eventually established seedling.

(iii) The future of current year's seedlings, i.e., recruitment (R) may be uncertain and they may not be considered important enough to be used in the eventual assessment of the status of regeneration. They may be recorded chiefly to throw light on seedling years and thus the year of origin of subsequently established plants.

(iv) Establishment height. This naturally varies with the species and environment. In this state we have always adopted 10 feet for *sal* which appears to be definitely on the upper side for some localities especially those not exposed to heavy browsing. Of course there is no method of fixing this figure precisely but from 5 to 10 feet would cover most localities for *sal*.

15. For *complete* assessment the following statistics should be collected for each quadrat :

(i) Total number of established plants .. .. (E)

(ii) Total number of unestablished seedlings in quadrats without (E) .. .. (U)

(iii) Total number of recruitment in quadrats without (E).. (R)

(iv) Actual height of four of the best unestablished seedlings (of all such seedlings if less than four) per quadrat ..

This can be easily done in form 30 (K).

16. In the discussion that follows the following notation would be used :

Number of milacre quadrats (assessment or recording units) in sampling units Nos. 1, 2, etc. .. .. .. N_1, N_2, etc.

Number of quadrats containing established regeneration (E) in sampling units Nos. 1, 2, etc. .. .. .. E_1, E_2, etc.

Number of quadrats containing unestablished regeneration (U) in sampling units Nos. 1, 2, etc. .. .. .. U_1, U_2, etc.

Total number of established plants (E) in sampling units Nos. 1, 2, etc. .. .. e_1, e_2, etc.

Total number of unestablished seedlings (U) in quadrats without (E) in sampling units Nos. 1, 2, etc. .. .. u_1, u_2, etc.

Total number of recruitment (R) in quadrats without (E) in sampling units Nos. 1, 2, etc. .. .. .. r_1, r_2, etc.

Sum of recorded heights of unestablished seedlings (U) in sampling units Nos. 1, 2, etc. .. .. .. h_1, h_2, etc.

Total number of observations for height of unestablished seedlings (U) in sampling units Nos. 1, 2, etc. .. .. n_1, n_2, etc.

Establishment height for the species and locality .. .. H

17. *For each sampling unit* the following statistics can be directly calculated :

(i) *Weighted average height of* E *and* U *in feet.* (In this calculation the height of every established plant is taken to be the establishment height H, irrespective of the *actual* height which may be more, but naturally never less, than H. The actual heights of U are taken).

$$= \frac{1}{U+E}\left\{\frac{h}{n}\cdot(U) + H.E\right\}$$

(ii) *Density of stocking per acre :*

Established regeneration (E) per acre $= \frac{1000\cdot e}{E}$ in $\frac{100\%}{N}$ of sample area.

Unestablished regeneration (U) per acre $= \frac{1000\cdot u}{N-E}$ in $\frac{100\,(N-E)\%}{N}$ of sample area.

(Unestablished regeneration can be subdivided into categories, e.g., below 2 feet, above 2 feet, etc.)

Recruitment (R) per acre $= \frac{1000\cdot r}{N-E}$ in $\frac{100\,(N-E)\%}{N}$ of sample area.

(Recruitment can be split up into sections, e.g., in quadrats without E, in quadrats without U, etc.).

Total regeneration (E+U+R) per acre $= \frac{1000\,(e+u+r)}{N}$ in whole of sample area.

For statistical analysis the density can be expressed with respect to the total area of the sample $= \frac{(E, e, u, r)}{N}\cdot 1000$ per acre.

Effective (U) per acre for the whole area $= \frac{n}{4N}\cdot 1000$ per acre.

in quadrats without E $= \frac{n}{4\,(N-E)}\cdot 1000$ per acre.

18. From these primary data which are adequate expressions for the status of regeneration, a number of coefficients can be calculated which (separately for each sampling unit or for the sample as a whole) numerically express particular or overall aspects of the state

of regeneration. They are to be treated as guiding expressions only and being derived units should better not be used for statistical comparisons :

The following expressions are derived for *the sample as a whole* (i.e., for all sampling units taken together).

S *stands for summation overall sampling units*

$$\text{Establishment coefficient} = \frac{\text{Weighted average height}}{\text{Establishment height}}$$

$$= \frac{1}{H\,\{S\,(U)+S\,(E)\}} \cdot \left\{ \frac{S\,(h)}{S\,(n)} \cdot S\,(U) + H.S\,(E) \right\}$$

$$\text{Stocking coefficient} = \frac{1}{S\,(N)} \cdot \left\{ \frac{S\,(n)}{4} + S\,(E) \right\}$$

$$\text{Established stocking per cent} = \text{Establishment coeft.} \times \text{stocking coeft.} \times 100$$

$$= \frac{100}{H.S\,(N)\,\{S\,(U)+S\,(E)\}} \cdot \left\{ \frac{S\,(h)}{S\,(n)} \cdot S\,(U) + H.S\,(E) \right\} \cdot \left\{ \frac{S\,(n)}{4} + S\,(E) \right\}$$

19. Established stocking % $= \dfrac{\text{av. ht.}}{H} \times \text{stocking coeft.} \times 100$

$$= \frac{100}{H} \times \text{av. ht.} \times \text{fraction of quadrats stocked}$$

$$= \frac{100}{H} \cdot \text{h. f say}$$

Average height and fraction of quadrats stocked are two primary variables which may be considered independent. There may be a certain amount of correlation but it is variable and as a first approximation it is reasonable to assume that they are independently subject to sampling error especially as average height is based only on a certain proportion of existing seedlings. Variance of the product (h.f.) when h and f are both independently subject to sampling error

$$V\,(\text{h.f.}) = h^2 \{ v\,(f) \} + f^2 \{ v\,(h) \}$$

Therefore, the S.E. of the established stocking factor should better be derived from the variance of the average height and the percentage of quadrats stocked and not directly as if it were a simple quantity.

PART II

LARGE SCALE REGENERATION SURVEYS

20. It is sometimes necessary, particularly during working plan revisions, to prepare detailed stock maps of regeneration in order to prescribe correct silvicultural treatment or merely to assess the status of regeneration in a particular area. Such surveys are of particular value for group shelterwood, group selection, and selection systems. Hitherto regeneration surveys had not been carried out in this state for purposes of W.P. or divisional control but in the *sal* working plans currently under revision, regeneration surveys are being undertaken more or less as a matter of routine. The introduction of more scientific group selection and selection systems (ultimately to follow the lines of *methode du control*) with separate calculation of yield and felling pattern to control diameter distribution in separate compartments or similar smaller units, with provision for special cultural treatment to existing groups of advance growth and appropriate operations to induce and encourage it where non-existent, makes it imperative to have a fairly detailed knowledge of the distribution of reproduction of all sizes below the lowest diameter class enumerated. Similarly in systems of concentrated regeneration

(chiefly irregular shelterwood group system) the vast variation in the density and size of advance growth from place to place within a comparatively small area necessitates fairly accurate stock mapping for prescribing cultural operations to suit different conditions.

21. Since the areas involved are of the magnitude of thousands of acres it is evident that only low intensity surveys could be economically feasible. The range of information collected is also severely restricted by considerations of degree of skilled supervision, time and costs.

22. If the growing stock is also being partially enumerated it is easiest and cheapest to combine the regeneration survey with tree enumerations. The sampling pattern adopted for the regeneration survey is, therefore, broadly governed by that of the partial enumerations. In plains forests, strip enumerations are by far the commonest ; occasionally line-plot surveys are also carried out. Under such conditions sub-sampling of the strips or line-plots is automatically adopted for assessment of regeneration. While the size and number of sampling units necessary to obtain an estimate of a given precision within a given cost has not been statistically determined (surveys have been carried out in concentrated regeneration under a shelterwood but the data has not yet been analysed from this angle) it is obvious that we have to be content with a low intensity sub-sampling of a pattern made to fit the system of partial enumeration. Again, since the primary use of regeneration survey data is to prepare a stock map of regeneration, the sampling units should be so dispersed as to give a convenient system of points on a grid for plotting.

23. The milacre quadrat (10 links $\times$ 10 links) is the most convenient recording unit. It is recommended for its convenient size and also because on analogy with 6 feet $\times$ 6 feet planting, about 1,000 suitably spaced established plants per acre are considered to correspond to complete stocking, and, therefore, all except one or two best seedlings may be disregarded. If a lesser number is considered adequate the recording unit can be correspondingly increased in size. Thus 680 plants per acre lead to a 8 feet $\times$ 8 feet recording unit whereas a 10 feet $\times$ 10 feet quadrat will mean only 436 plants per acre. It is, therefore, evident that the recording unit has to be kept fairly small if it is to fulfill the purposes of a regeneration survey in a satisfactory manner and the choice will probably lie in the range 6 feet square to 10 feet square. Larger recording units would be unsuitable, both because more than one plant of a particular category will have to be recorded, and more troublesome to lay out. Since not only the number but also the disposition of the seedlings is a matter of importance and only one of two or more closely spaced seedlings is "effective", and because counting one seedling per milacre quadrat ensures a reasonable distribution of an adequate number of seedlings, therefore, in the U.P., milacre quadrats are being prescribed for all regeneration surveys both for research and working plan purposes.

24. Milacre quadrats can be very conveniently formed by two 6·6 feet long light bamboo staves laid at right angles to two successive 10 link tags on the gunter's chain spread on the ground. The observer walks along the chain and records the regeneration on one or both sides of the cruise-line as the case may be, while one or two labourers keep on shifting the bamboo rods to fresh positions. The same procedure can be adopted for forming larger quadrats up to say 10 feet $\times$ 10 feet but the method is unsuitable for still bigger ones.

SAMPLING PATTERNS

25. *Strip and line plot surveys in easy terrain*—Some appropriate patterns for sub-sampling regeneration during strip and line-plot enumeration of the usual intensity are considered below :

(i) 20% systematic, centrally located, 2 chain wide enumeration. If regeneration is sampled in 6·6 feet wide strips, on one or both sides of the cruise-line then

1% and 2% sampling will be respectively attained. The middle points of sampling units will be distributed at ten chain intervals along one dimension of the stock map and, therefore, regeneration data may be computed separately by 5 or 10 chain lengths to give a good plotting grid. Only one or two points per acre would be available for plotting – but if the size of the area is not less than 50 acres, the resulting stock map would be adequate enough to form the basis for sub-compartmentation for differentiation of cultural treatments (Figs. 1 & 2).

(ii) 10% systematic, centrally located, strip enumeration. In this case it would be preferable to enumerate the growing stock in one chain wide strips otherwise the points for plotting regeneration would be too far apart. In this case again 10 links wide strips on one or both sides of the cruise-line would yield a sampling intensity of 1% and 2% respectively.

(iii) 5% systematic, centrally located, strip enumeration. With one chain wide tree enumeration strips spaced 20 chains apart, 10 links wide regeneration sampling strips on one or both sides of the cruise-line will mean 0·5% and 1% sampling intensity. This is obviously a sampling pattern of low precision, both for the growing stock and the regeneration, for areas of the order of a few hundred acres ; but it is considered good enough for areas of the order of over a thousand acres, i.e., for felling series and working circles as a whole.

(iv) 10% line-plot survey with 2 chains × 1 chain rectangular plots. With points disposed 5 chains apart in one dimension and 4 chains apart in the other a reasonable plotting grid is obtained. The 0·2 acre plot may be centrally sub-sampled for regeneration by laying-out 6·6 feet strips on one or both sides of the cruise-line, yielding a regeneration sampling intensity of 0·5 or 1% respectively (Fig. 2).

(v) 5% line-plot survey with 1 chain × 1 chain square (or circular) plots. The plots should again be distributed at 5 chains × 4 chains intervals and sub-sampling carried out as before to an intensity of 0·5% or 1%.

(vi) 2% (approx.) line-plot survey with 1 chain × 1 chain square (or circular) plots. In this case the main sampling plots may be arranged in a 7 chains × 7 chains pattern. One or two 6·6 feet wide strips along the 66 feet length of the plot will yield a sub-sampling intensity of 0·2 or 0·4%. The low sub-sampling intensity would be in keeping with the low precision of the main sampling for the growing stock.

26. In case of line-plot surveys a lower intensity of sub-sampling (0·2 to 1%) has been indicated than that for strip enumerations (0·5 to 2%). This is in harmony with the well known fact that the greater dispersion of line-plots usually results in a lower estimated sampling error as compared to strip surveys of identical intensity. Therefore, a lower sub-sampling intensity has been considered adequate (not on statistical evidence, it must be admitted) for the large areas to be sampled, though it will perhaps not give good stock maps.

27. The degree of sampling can be increased or reduced if there is some particular reason to do so but the high cost of such surveys will preclude much greater sampling intensities. In a regeneration survey carried out in Gorakhpur forests, laying out two 6·6 feet wide strips on either side of the cruise-line and using a milacre recording unit, the cost amounted to -/1/3 to -/1/6 per linear chain covered. This is for the regeneration survey alone. When it is

combined with enumerations, the crusing would be common to both samplings and the overall expenses would fall, the regeneration survey costing -/-/6 only per linear chain. (These estimates exclude the pay of the Forester who does the recording).

28. When regeneration surveys are being conducted apart from partial enumeration of growing stock, the designs indicated above can be adopted or others evolved. The general principle remains the same. Line-plots though slightly costlier for a given degree of sampling will yield results of greater precision, better adapted for preparing stock maps.

29. *Collection of data*—In regeneration surveys it should suffice to record the occurrence of the most promising categories of reproduction only and in case of *sal* forests, where such surveys have their greatest utility in this state, it should suffice to concentrate attention on saplings and poles *below* the lowest diameter limit of tree enumeration, on established plants, and woody shoots on way to establishment. It is only when these classes are absent that the necessity to record smaller seedlings should arise. Establishment height may be fixed from 5 feet to 10 feet depending upon local factors.

30. Adopting the milacre quadrat as a recording unit, the following classes of regeneration may be distinguished. This is with particular reference to *sal* natural regeneration in U.P. Categories suitable for other species should be specifically established.

Symbol	Category of regeneration	Explanation
e	*established* regeneration, up to the lowest limit of tree enumeration, usually 4 inches d.b.h.	Symbol e will indicate that at least one such plant is present, which is sufficient to stock the quadrat.
w	*woody unestablished* regeneration, large and vigorous and expected to become established early.	If there is no e one w will be sufficient to stock the quadrat.
u, $u+$	*non-woody, unestablished* seedlings.	If there is no e or w, u will indicate that one, or $u+$ will indicate that more than one unestablished seedlings are present in the quadrat.
r	*recruitment* (current year's seedlings).	If there is no e, w, or u then recruitment may be recorded.

31. It may suffice to combine e and w and neglect r, or to record ($e + w$) and u, or ($e + w$) alone, in large projects where detailed information is not required.

32. *Classification of data for stock maps*—The data may be classified for plotting according to the nature of information required for specific purposes. A detailed classification is given below :

	Class No.	Proportion of various categories of regeneration		
unstocked	1	$e+w+u+$ below 10%	..	.. ..
	2	e below 10%;	$e+w$ up to 25%;	$e+w+u+$ up to 75%
	3	,,	,,	$e+w+u+$ over 75%
	4	,,	$e+w$ over 25–50%;	$e+w+u+$ up to 75%
deficient in e	5	,,	,,	$e+w+u+$ over 75%
	6	,,	$e+w$ over 50–75%;	$e+w+u+$ up to 75%
	7	,,	,,	$e+w+u+$ over 75%
	8	,,	$e+w$ over 75%;	.. ..
	9	e over 10–25%;	$e+w$ up to 50%;	$e+w+u+$ up to 75%
	10	,,	,,	$e+w+u+$ over 75%

(*contd.*)

	Class No.	Proportion of various categories of regeneration		
promising in *e*	11	*e* over 10–25% ;	$e+w$ over 50–75% ;	$e+w+u+$ up to 75%
	12	,,	,,	$e+w+u+$ over 75%
	13	,,	$e+w$ over 75% ;	.. ..
	14	*e* over 25–50% ;	$e+w$ up to 75% ;	$e+w+u+$ up to 75%
fair in *e*	15	,,	,,	$e+w+u+$ over 75%
	16	,,	$e+w$ over 75% ;	.. ..
	17	*e* over 50–75% ;	$e+w$ up to 75% ;	$e+w+u+$ up to 75%
good	18	,,	,,	$e+w+u+$ over 75%
	19	,,	$e+w$ over 75% ;	.. ..
excellent	20	*e* over 75% ;	..	.. ..

33. This detailed classification need not deter by its length because in general only a few classes will preponderate in any one type of area. A compartment may be broadly divisible into 2 or 3 portions in each of which a particular set of a small number of classes will predominate (Fig. 1). Of course much simpler classifications could be used : for instance only the following broad classes may be distinguished :

Class No.	Proportion of various categories of regeneration		
I	$e+w+u+$ less than 10%	..	.. ..
II	*e* below 33% ;	$e+w$ up to 66% ;	$e+w+u+$ up to 80%
III	,,	,,	$e+w+u+$ above 80%
IV	,,	$e+w$ above 66% ;	.. ..
V	*e* over 33–66% ;	$e+w$ up to 66% ;	$e+w+u+$ up to 80%
VI	,,	,,	$e+w+u+$ above 80%
VII	,,	$e+w$ above 66% ;	.. ..
VIII	*e* above 66% ;	..	.. ..

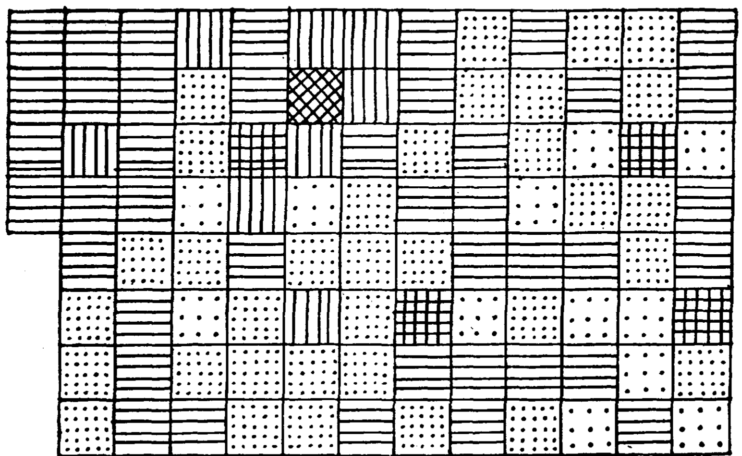
34. *Stock maps*—The data so collected can be most conveniently plotted on a map if the area is divided into a number of rectangles or squares in such a manner that the sampling unit is situated centrally in each of them. Then assuming that the sampling unit is representative of the square, that square is given the appropriate class number and coloured correspondingly. Any degree of fragmentation is possible but a 5 chains × 5 chains square is a convenient plotting unit for 4 inches = 1 mile scale maps. Fig. 2 shows a map prepared from an actual survey. The data for each 5 chain length (100 milacre quadrats, 50 on either side of median cruise-line) has been totalled separately and allotted the regeneration class number.

35. *Regeneration surveys in difficult terrain where cruising is impracticable*—In large tracts it is difficult to impossible to conduct ordinary survey operations and strip or line-plot surveys are not attempted even for estimating growing stock. Instead, either total enumerations are done or partial sampling is carried out with whole compartments, sub-compartments or topograpical units (*Indian Forester, January, 1951*) as sampling units. In the U.P., most of hill *sal* forests which are managed under the selection system lie in such difficult terrain. It is consequently especially difficult to ascertain by ocular methods if there is a continued inflow of regeneration into the lowest diameter class. It is needless to emphasize that it is particularly in such areas that regeneration surveys are of the greatest potential value. With more intensive management, in conjunction with adoption of improved exploitation practices, e.g., on the lines of *methode du control,* and periodic cultural operations to induce and establish regeneration in discrete wide-apart patches, some form of cruising would be absolutely essential in order to gain a reasonably satisfactory picture of the growing stock and regeneration. Meanwhile, at this stage, when even the working plan enumerations are carried out over

REGENERATION STOCK MAP

NAGWA 4 (pt)

E 24.1% ; U+ 18.5%
W 10.03%; U 10.7%



Regn. Class No. & %

2.	12%
9.	34%
14.	41%
15.	8%
18.	4%
19.	1%

Figure 1.

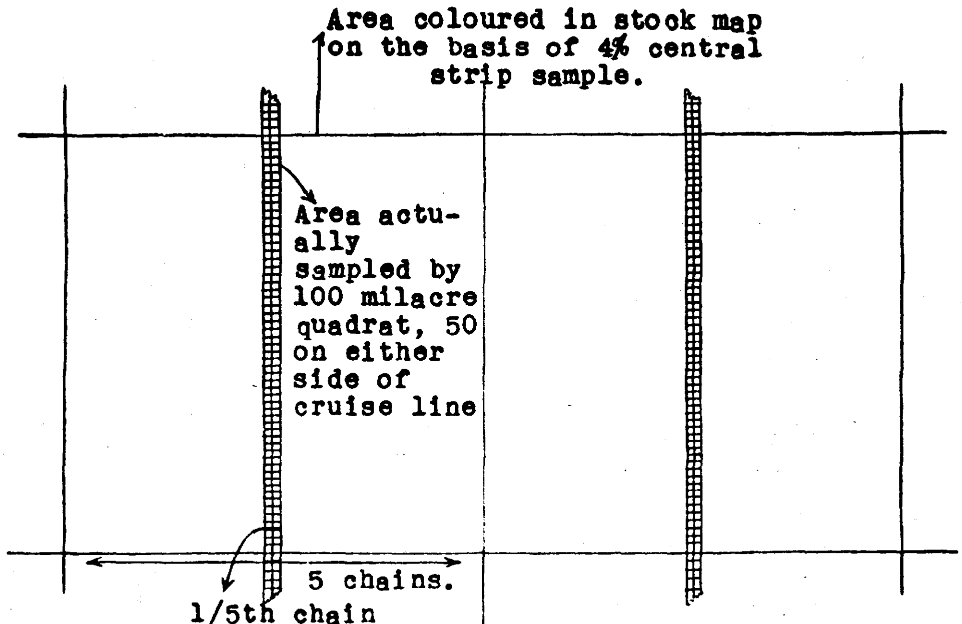


Figure 2.

2 e upto 10%; e + w upto 25%; e + w + u upto 75%
9 e over 10-25%; e+w upto 50%; e+w+u upto 75%
14 e over 25-50%; e+w upto 75%; e+w+u upto 75%
15 e over 25-50%; e+w upto 75%; e+w+u above 75%
18 e over 50-75%; e+w upto 75%; e+w+u above 75%
19 e over 50-75%; e+w above 75%

selected whole compartments, a system of sampling regeneration has to be devised which may at least give some idea, however inadequate, of its extent and distribution. To start with, a very low overall intensity of sub-sampling say 0·1 to 1% might be considered enough for these large areas.

36. Under such conditions *randomization in time* is a practicable alternative to randomization in space. By this means it is possible to achieve an unbiassed sampling which is the essence of randomization, even though it may not be possible precisely to locate the sampling units on a map. Instead of survey equipment only an ordinary watch is required which could be easily provided. In actual practice the sampling units could also roughly be located on map if so required.

37. Consider the following sub-sampling scheme : The area of the sub-compartment or topographical sampling unit is known from the map. It could also be calculated directly how many sampling units of a given size would be required to achieve the required degree of sub-sampling for regeneration. The average speed of tree enumerations and the average width of the enumeration "strip" is approximately known from experience and inspection of the lie of the area reveals the direction enumerations would take. It is, therefore, possible to estimate the number of "strips" the enumerating party would form in order to cover the area and hence the number of regeneration sub-sampling units which should be formed in each of these "strips". The instructions for sub-sampling could simply take the form : "In each ' strip ' (or compartment) lay out regeneration sub-sampling units at 10, 12, 14, 16 hours, etc. (for an approximate systematic pattern) or 9, 10, 13, 14, 16 hours, etc. (for a restricted random pattern)". The only thing to impress upon the enumerating party is the fact that, irrespective of the condition of the forest, the sub-sampling units should be formed at precisely the indicated time or time-intervals by *the enumerators' watch*. Only relative time is important for eliminating bias and it is largely immaterial how inaccurate the enumerators' watch is so long as the time intervals can be estimated with reasonable accuracy.

38. A 4 milacres (13·2 feet square) sub-sampling unit would appear to be convenient for main topographical sampling units of 50 acres or so. For larger areas (sub-compartments or compartments) oblong plots of 13·2 × 33 feet (10 milacres) or 13·2 × 66 feet (20 milacres) could be used. The recording unit might be the milacre quadrat and the whole laid out by the help of ropes and light bamboo rods. A convenient system of recording, e.g., that given in paras 37 and 38 might be used.

39. As an example consider 1% sub-sampling of a 250 acres compartment. If the sampling unit is 20-milacre quadrat, 125 such units would be required. If the average speed of tree enumerations plus sub-sampling is 50 acres per day of 5 working hours, and the usual width of the enumeration "strip" is one chain, 2·5 plots per strip are needed. In this case the enumerator could be asked to establish a sampling unit every 10 minutes, 15 minutes after starting work ; alternatively he could be ordered to lay out 2 or 3 plots per strip, the time interval between plots being say 8 minutes. It is immaterial in what portion of the strip the plots actually lie ; an unbiassed random distribution has been achieved and it is all that is required.

PART III

ESTIMATES AND ERRORS OF ESTIMATES

40. Appropriate statistical methods for analysing data collected from random samples are well known and are not being mentioned here. However, systematic sampling is so well established in forestry that despite a lack of strictly valid statistical procedures to estimate the reliability of data collected in this manner, it will perhaps continue to be used. The reasons for

this preference are definite, partly the inherent simplicity of systematic procedures which reduces high level supervision and partly the advantages of systematic samples, since it is well known that, provided there are no pronounced periodicity trends or strip effects, systematic samples yield closer estimates as compared to random ones, though it is not possible to accurately determine the limits of error the latter are subject to. Since this paper deals mostly with systematic patterns, the methods recommended for analysing systematic data are briefly mentioned. For details the publications cited should be consulted.

41. Yates (1) has made various suggestions. The material could be arbitrarily divided into strata and the sampling error calculated as if the units were selected at random. For one-dimensional sampling pairs of successive units may form strata so that the error variance is estimated from the differences between the members of the pairs. Instead of alternate differences between successive units, all differences may also be taken. In this case the variability due to differences in the lengths of lines or strips may be eliminated by the ratio method, using a constant or a variable ratio. If the total area is not known then the ratio method is inapplicable. For two-dimensional sampling on a square or rectangular pattern the strata should consist of sets of 4 units in 2×2 pattern, thus accounting for variability in both directions.

42. The above methods will in general give over-estimates of the sampling error subject to certain reservations regarding periodicity and strip effects in the material. For closer estimates (though still overestimates in general) the method of "balanced differences" may be used both for one-dimensional and for two-dimensional sampling. For still more exact estimates, supplementary observations have to be taken at intermediate points allocated systematically or at random (2).

43. Orthogonal polynomials could also be used for analysing systematic data (3). The method amounts to evaluating the definite integral of a polynomial function fitted to the observed values by the method of least squares up to the point where the residuals behave randomly, and using the residuals to exhibit the error to which the estimate (integral) is exposed. It is assumed that data per unit length or area collected from a systematic one-dimensional or two-dimensional sampling grid vary from point to point in such a manner that they can be represented by a polynomial and the differences between the estimated and true values at the same points are independent and have a constant variance. This assumption may often be approximated and preclude serious error. The method of polynomials could be used wherever a set of equally spaced samples is taken for the purpose of estimating a quantity.

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CONVOCATION OF THE INDIAN FOREST COLLEGE AND THE INDIAN FOREST RANGER COLLEGE, DEHRA DUN, 1953

The Convocation of the Indian Forest College and the Indian Forest Ranger College, Dehra Dun, was held on Tuesday the 31st March, 1953, at 3 p.m. in the Convocation Hall of the Forest Research Institute. The ~~hall was very tastefully~~ decorated for the purpose. This year we had the honour of Shri K. M. Munshi, Rajyapal, Uttar Pradesh, distributing the diplomas, certificates, medals and prizes to the successful students of the Indian Forest College and Indian Forest Ranger College, and the Hon'ble Minister of Agriculture, Government of India, Doctor Punjabrao Shamrao Deshmukh delivering the Convocation Address. A distinguished gathering of the *elite* of Dehra Dun and its environs had foregathered to honour the occasion.

Escorted by the Director of Forest Education and followed by the Inspector-General of Forests, the President, Forest Research Institute and Colleges, and the Principal of the Indian Forest Ranger College, Shri K. M. Munshi, Rajyapal, Uttar Pradesh and the Hon'ble the Minister for Agriculture to the Government of India, Dr. P. S. Deshmukh, proceeded to the dais and took their seats punctually at 3 p.m.

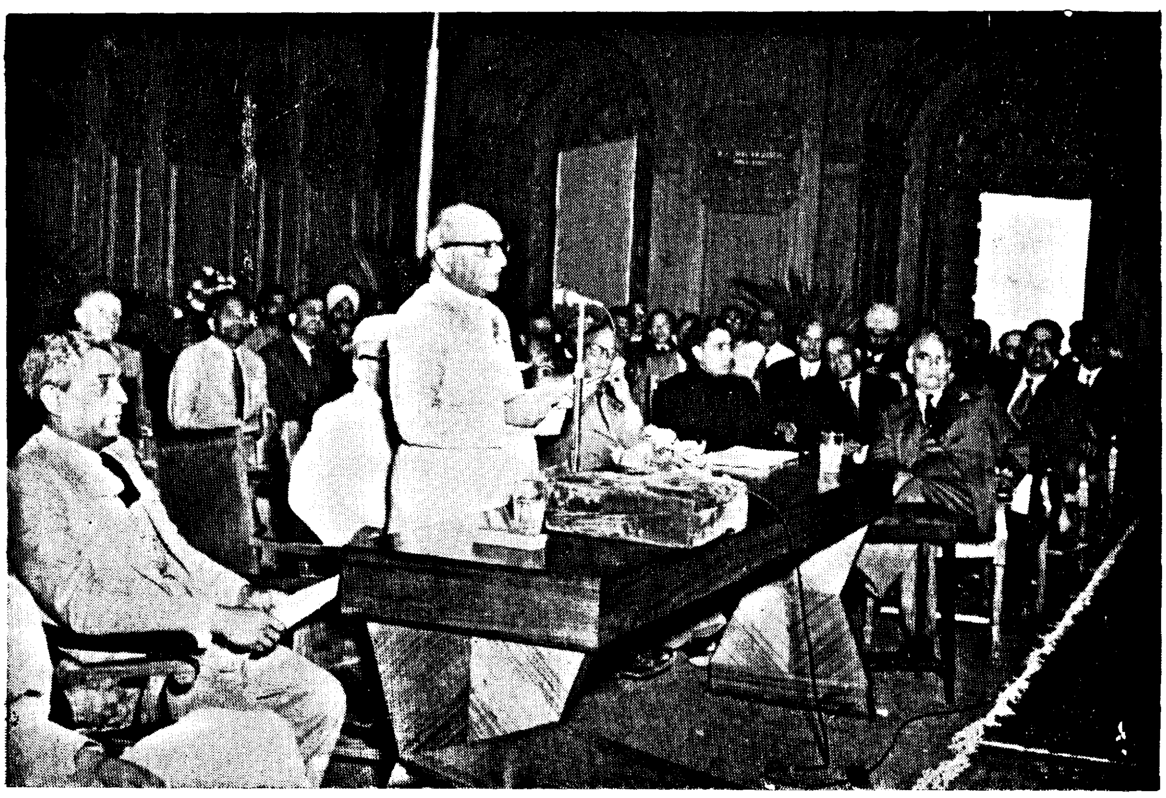
Shri C. R. Ranganathan, I.F.S., President, Forest Research Institute and Colleges, welcomed Shri Rajyapal and the Hon'ble Minister and those assembled in the following words :—

"Shri Rajyapal, Dr. Deshmukh, Ladies and Gentlemen,

It is my pleasant duty to open the proceedings of this Convocation by extending a warm welcome to all present. May I say how happy and honoured we feel in having with us to-day the distinguished Governor of Uttar Pradesh. Shri Munshi is, of course, no stranger to us in this Institute. He was our Minister during an eventful period and is familiar with our work. He honoured us by delivering the Convocation Address in 1951. In welcoming him on that occasion, I referred to the contributions he had made to very varied fields of activity : art and literature, law and politics, history and education, etc. I may be prejudiced, but I do believe that it was during his all too brief tenure of the Central Ministry of Agriculture that he made what many of us consider the most far-reaching and valuable contribution of his career, namely, his successful drive to change the psychology of the people in regard to trees, tree growth and forestry. He has always maintained that first things must come first in the regeneration of India and that forests are the foremost among the first things in the economy of a country. Thanks to his powerful voice, measures to arrest the spread of the Rajasthan desert are now not merely front page news but an active campaign ; and tree planting has become a popular national festival. In him Indian forestry has a firm friend and a strong protagonist. When the news of his appointment as Governor of this State was first announced, there was great satisfaction amongst us and we felt certain that he would revisit the Institute during the first year of office. His visit has been delayed, but since it is not quite a year since he assumed his high office, I think that technically our expectation has been fulfilled.

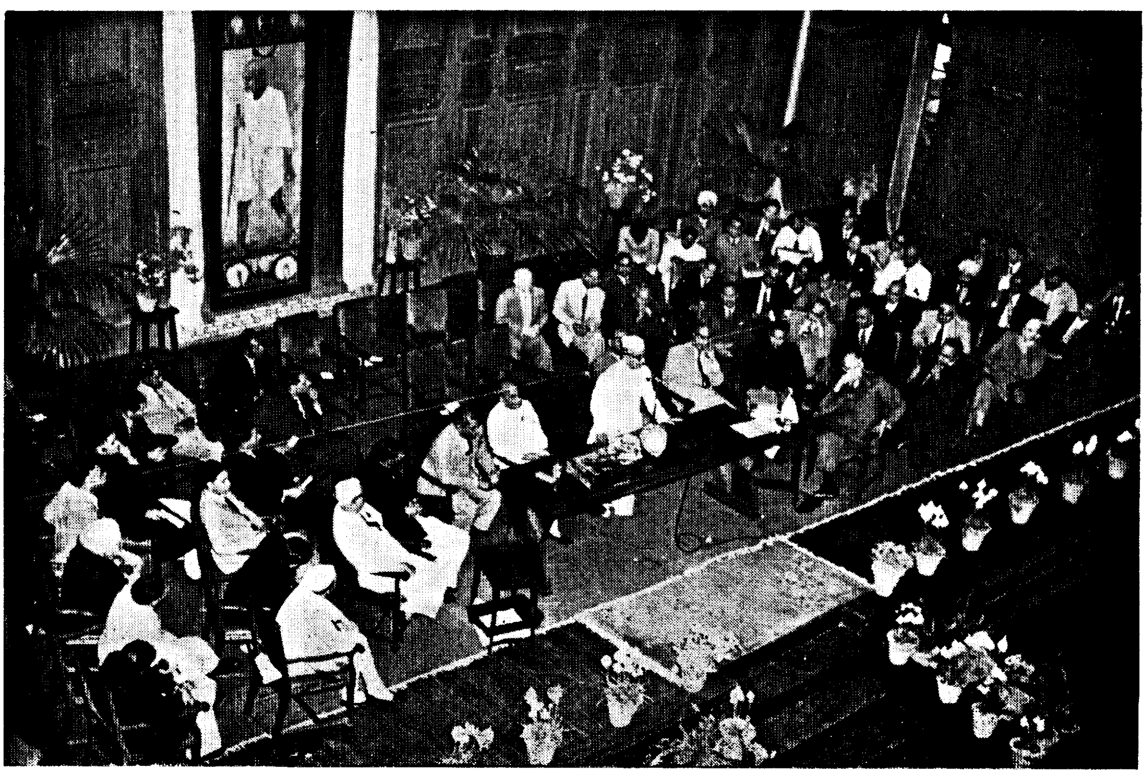
"May I say a special word of welcome to our Minister, Dr. Deshmukh. It is indeed very kind of him to have found time in the midst of his parliamentary and other preoccupations to be with us to-day to deliver the Convocation Address. We know that his interest in forestry and in the work of this ancient institution is great. On the last occasion that he visited the

Shri C. R. Ranganathan, I.F.S., President, Forest Research Institute, delivering his welcome address. Convocation 1953.



Hon'ble Doctor Punjabrao Deshmukh, Minister of Agriculture, Government of India; delivering the Convocation Address.

Presentation of miniature *Vana Mahotsava* Shield to Shri K. M. Munshi, Rajyapal, U.P. Convocation 1953.



View of the dais from balcony. Convocation 1953.

Institute he spoke words of encouragement to the workers here and promised to support the legitimate interests of this organization.

"On these occasions I usually do some loud thinking and make some rambling remarks on some aspect of the forestry position in India. To-day, however, I must refrain from this indulgence as we have a rather full programme before us. We have to go through our customary formalities before listening to the addresses of our Governor and our Minister, and I do not wish to take up any more of your time. I must, however, refer to the loss that the staff of the Institute and Colleges has sustained through the recent transfer of Shri K. L. Aggarwal to his State. Shri Aggarwal held the double post of Director of Forest Education and Publicity and Liaison Officer and discharged his onerous responsibilities with credit and diligence. We certainly tried to retain him here, but Punjab pressed for his return and we had regretfully to let him go. Shri Mathur is acting as Director of Forest Education and I will now ask him to present his report".

Then the report on the 1951–53 Course of training given to the outgoing students and on the working of the forest colleges for the year 1952–53, was presented by Shri V. P. Mathur, Dean of the Indian Forest College and Acting Director of Forest Education. As Dean of the Indian Forest College, he announced the results of the 1951–53 Course and requested Shri Rajyapal to give away the diplomas and prizes.

"Shri Rajyapal, Dr. Deshmukh, Ladies and Gentlemen,

I beg leave to present the report on the working of the 1951–53 Courses of instruction in Forestry, the students of which are passing out to-day ; as also on the general working of the Forest Colleges at Dehra Dun during the year 1952–53.

"As in the past, two parallel courses were conducted – a Superior Forest Service Course at the Indian Forest College for Forest Officers ; and a Forest Rangers' Course at the Indian Forest Ranger College for Forest Rangers.

"The Indian Forest College dates from 1938, and the 1951–53 Class, which passes out to-day, is the 11th to complete its training. The College conducts a two-year course for the training of gazetted forest officers of the various States of the entire Union as well as of our close neighbours. Thirty-one officers are passing out to-day.

"The Indian Forest Ranger College is a very much older institution and dates back to 1878, and was indeed the fore-runner of this Institute of ours which has now grown to its present proportions and has established itself as a world-famous and unique institute of its kind. Over a period of 74 years, the Rangers' College has trained nearly 2,400 Forest Rangers who have formed the backbone of the Forest Services all over India. Many of these Rangers have risen to higher positions. To-day, 69 Rangers are passing out from this College.

"Admission to the two Colleges is confined entirely to nominees of the State Governments. Although these courses serve primarily the requirements of States in India, candidates from adjacent countries, such as Nepal, Iran and Ceylon have also been trained here from time to time. Amongst those who are to-day passing out successfully after completing their course, there are three candidates from Nepal, one in the Indian Forest College and two in the Indian Forest Ranger College. Under the Government of India Cultural Scholarships' Scheme for studies in India, five seats in the Diploma Course and ten seats in the Rangers' Course in Forestry for candidates from abroad, both of Indian and non-Indian origin, are reserved for each year.

"It is a matter of pride that our Institute has been accepted by the F.A.O. as a recognized centre of training and advanced studies for forest officers and technicians for the South-East

Asian region. It is hoped that increasing advantage will be taken of the well-equipped Colleges here by these countries to send their forest officers for training.

"*Courses of studies*—The courses followed established lines. These include studies in the lecture rooms, in the laboratories and in the field. In addition to all aspects of commercial and State forestry, the students of both the Colleges have also had the benefit of instruction in soil conservation, planned land use, road-side avenues, canal bank plantations, farm-forestry and several other specialized practices for which forest officers are now called upon to assist and advise in an increasing degree and through which the trained forest officer will be able to contribute more and more to the welfare and uplift of our predominantly agricultural population.

"In 1950, in addition to the normal courses in the Indian Forest College, training in extra-curricular activities was introduced and during 1951 these activities were further augmented and expanded by the introduction of facilities for out-door hobbies, such as learning photography and practice in rifle shooting. During the year under report, due to the kind courtesy of the Commandant, National Defence Academy, the officer students were given one month's training in riding. Specialized training in particular selected subjects by individual students under the direct supervision and guidance of the research officers of the Forest Research Institute was continued.

"Finally, we have introduced an entirely new idea of inviting eminent forest officers from States to deliver lectures to the students on their own special subjects.

"To all those officers, who took up lectures at the two Colleges, as well as to those research officers, who in addition to the lectures, supervised and guided individual students in their special advanced study, I take this opportunity of expressing our gratitude.

"*Tours and field work*—In keeping with the essentially practical nature of a forester's duties, the courses involved quite half the period in each year in practical field work under varied forest conditions, for which purpose educational tours to the various forest areas in the country were conducted as usual. Our sincere thanks are due to the various forest officers in the States through whose co-operation these tours could be completed successfully.

"*Examination and results*—Senior Forest Officers from States, Research Officers from the Institute and other external examiners were invited to examine the students in the first year and final examinations. We are grateful to these officers for undertaking this responsibility in the midst of their own multifarious duties. The students were also assessed for work done on tours, for practical field work, and for general proficiency and conduct.

"*Staff*—The regular staff of the two Colleges consists of serving forest officers on deputation, who conduct the classes in forestry subjects and are responsible for all the field training. In addition, the students get the benefit of training from highly technical officers of the Research Institute who are specialists in their own fields. Besides these research officers and serving forest officers, there are on the staff of the Colleges separate lecturers for Engineering, Surveying and a Physical Training Instructor.

"*Health*—The general health of the out-going students of both the Colleges remained good throughout the course, except for minor ailments, which are inevitable where such a large number of students is concerned.

"*Games and Sports*—Robust physique and sound health being one of the essential requirements for the efficient discharge of a forest officer's duties, physical training in the morning and games in the evening continued to remain compulsory while the students were at headquarters.

"*Conclusion*—I would now seek the indulgence of this Convocation to let me address myself to the out-going students.

"As you are aware, the Ranger College has built for itself a great reputation in the last 74 years of its useful existence. The Indian Forest College, though a much younger institution, has built for itself an equally good reputation. I have, in the last six years, had opportunities to see for myself many young men from our Colleges acquitting themselves creditably in positions of considerable responsibility, though they had to shoulder the same at comparatively early stages in their careers. We, of the teaching staff, have made every endeavour possible to ensure that you received at least as good a training as any of your predecessors ; and in our turn we do look forward to your proving yourselves worthy of this Alma Mater of yours, by your good work in the forests of whichever State or country you serve. That hard work, a high sense of duty and responsibility, total integrity, a high order of professional skill and great personal enthusiasm are the chief requisites for success in life has been repeatedly brought to your notice during your training here. I would ask you to keep this constantly in mind as also the fact that the effect of much of your work will react more on the future generations than on the present and that you owe it to posterity that your work should be properly conceived and honestly carried out. Undertake your new tasks with confidence in your ability, but with that humility which is necessary to serve the people well. Go forward with the determination to uphold the traditions of good service built up by the forest services of India.

"I shall now, in my capacity as the Dean of the Indian Forest College, announce the results. I have great pleasure in announcing that all the 31 students of the 1951–53 Course of the Indian Forest College have successfully completed the Diploma Course of training in Forestry. I am further glad to announce that

(1) Shri H. B. Joshi .. Uttar Pradesh
(2) Shri V. P. Singh .. Uttar Pradesh
(3) Shri Bharat Singh .. Rajasthan
(4) Shri M. D. Joshi .. Hyderabad

have qualified for the award of a Diploma with Honours.

"The Diplomas, which will be awarded to-day, will entitle the recipients to the use of the letters – 'A.I.F.C.' (i.e., Associate of the Indian Forest College) after their names as a distinction of their technical training at this College.

"I now have the pleasure to announce the results in order of merit and would request the students whose name is announced to approach the dais to receive the Diploma. May I request you, Sir, to be kind enough to give away the Diplomas and prizes to the successful candidates".

INDIAN FOREST COLLEGE

FINAL RESULTS OF THE 1951–53 COURSE

Serial No.	Name of Student	State	Serial No.	Name of Student	State
In order of merit.—			PASS (50% and over).—		
HONOURS (75% and over).—			5	R. D. GUPTA	.. Uttar Pradesh
1	H. B. JOSHI	.. Uttar Pradesh	6	G. P. SINGH	.. Uttar Pradesh
2	V. P. SINGH	.. Uttar Pradesh	7	A. R. MOON	.. Madhya Pradesh
3	BHARAT SINGH	.. Rajasthan	8	S. N. KRISHNA-MURTHY	.. Mysore
4	M. D. JOSHI	.. Hyderabad			

(*contd.*)

INDIAN FOREST COLLEGE

FINAL RESULTS OF THE 1951–53 COURSE—(*concld.*)

Serial No.	Name of Student	State	Serial No.	Name of Student	State
9	M. S. SOLANKI	.. Madhya Pradesh	21	L. B. B. RANA	.. Nepal
10	A. F. OSWALD	.. Vindhya P.	22	V. S. SASTRI	.. Hyderabad
11	N. K. JOSHI	.. Madhya Pradesh	23	S. P. MISHRA	.. Madhya Pradesh
12	SOHAN SINGH	.. Kashmir	24	GULAM RASUL	.. Kashmir
13	A. M. T. DEVAR	.. Madras	25	K. G. VENKATRAM	.. Madhya Pradesh
14	H. K. BAISYA	.. Assam	26	T. KRISHNAMURTHY	.. Hyderabad
15	K. S. SANKHLA	.. Rajasthan	27	S. C. AGARWAL	.. Madhya Pradesh
16	H. P. CHOTHIA	.. Saurashtra	28	P. J. GURJAR	.. Madhya Pradesh
17	A. TEWARI	.. Bihar	29	K. RAMAGOWDA	.. Madras
18	D. SINHA	.. Bihar	30	T. C. GOSWAMI	.. Assam
19	M. C. AGARWALA	.. Madhya Pradesh	*Not ranked.*—		
20	J. MISHRA	.. Bihar	31	P. C. DAS	.. Orissa

LIST OF PRIZE WINNERS

Serial No.	Prize	Name of Student	State
1	HONOURABLE MINISTER'S PRIZE FOR STUDENT STANDING 1ST.	H. B. JOSHI	.. Uttar Pradesh
2	COLLEGE PRIZE FOR SILVICULTURE ..	M. D. JOSHI	.. Hyderabad
3	COLLEGE PRIZE FOR FOREST MANAGEMENT.	H. B. JOSHI	.. Uttar Pradesh
4	COLLEGE PRIZE FOR ENGINEERING AND SURVEYING.	R. D. GUPTA	.. Uttar Pradesh
5	COLLEGE PRIZE FOR BOTANY ..	S. N. KRISHNAMURTHY	.. Mysore
6	BEST ALL-ROUND STUDENT AND THE MOST PRACTICAL FORESTER.	H. B. JOSHI	.. Uttar Pradesh

Shri H. B. Joshi (from Uttar Pradesh) who stands first is being recommended for the award of the Currie Scholarship. The Scholarship is paid from a trust fund in England to the student of the Indian Forest College who obtains the highest marks for the Course and is equivalent to about £35.

Mr. Currie was Vice-President of the Council of India and in 1887 established the fund for prizes to be awarded to the probationers trained at the Royal Indian Engineering College at Cooper's Hill for the Indian Forest Service.

After the diplomas and prizes were awarded to the out-going students of the Indian Forest College, Shri G. S. Dhillon, Principal of the Indian Forest Ranger College, announced the results of the 1951–53 Course of his College and requested Shri Rajyapal to award the certificates, medals and prizes to the successful students. The Principal's speech and the results of the final examinations of the 1951–53 Course is given below :—

"Shri Rajyapal, Dr. Deshmukh, Ladies and Gentlemen,

"I am glad to announce that all the 69 students of the 1951–53 Course have passed. Out of these, three have qualified themselves for the Honours Certificate namely B. S. Rawat

of Uttar Pradesh, Rajinder Singh of Punjab and J. N. Dulloo of Kashmir ; 65 for the Higher Standard and 1 for the Lower Standard.

"I shall now call these students in their order of merit for the award of Certificates to them by Shri Rajyapal".

INDIAN FOREST RANGER COLLEGE, DEHRA DUN

EXAMINATION RESULTS—FINAL OF 1951-53 COURSE

Serial No.	Name of Student	State	Serial No.	Name of Student	State
In order of merit.—			34	H. M. P. Verma	.. Bihar
			35	S. L. Sharma	.. Madhya Pradesh
HONOURS.—			36	D. N. Pateria	.. Madhya Pradesh
1	B. S. Rawat	.. Uttar Pradesh	37	Mahendra Mishra	.. Bihar
2	Rajinder Singh	.. Punjab	38	C. L. Gandotra	.. Kashmir
2	J. N. Dulloo	.. Kashmir	39	S. R. Singh	.. Bhopal
			40	Keshari Prasad	.. Uttar Pradesh
HIGHER STANDARD.—			41	C. R. Mahto	.. Bihar
4	G. S. Saxena	.. Uttar Pradesh	42	J. P. Shrivastava	.. Bhopal
5	M. K. Paturkar	.. Madhya Pradesh	43	Mohammad Shafi	.. Kashmir
6	B. Chaini	.. Madhya Pradesh	44	M. R. Patel	.. Madhya Pradesh
7	S. M. Jain	.. Rajasthan	45	S. M. Nath	.. Bengal
8	J. R. Sen	.. Bengal	46	S. N. Singh	.. Bihar
9	S. N. Bande	.. Madhya Pradesh	47	M. S. Rajawat	.. Rajasthan
9	H. S. Pritam	.. Kashmir	48	S. B. Khule	.. Madhya Pradesh
11	Jagdish Mittar	.. Punjab	49	M. M. Jain	.. Rajasthan
12	Jai Prakash	.. Himachal P.	50	U. P. Gogoi	.. Assam
13	V. N. Ghei	.. Madhya Pradesh	51	R. P. Gupta	.. Himachal P.
14	H. R. Sud	.. Himachal P.	52	N. G. Chatur	.. Madhya Pradesh
15	A. K. Deb	.. Bengal	53	M. L. Deshpande	.. Madhya Pradesh
16	D. S. Singh	.. Uttar Pradesh	54	S. R. Sangar	.. Madhya Pradesh
17	V. K. Mishra	.. Uttar Pradesh	55	H. C. Chokse	.. Madhya Pradesh
18	D. S. Tipre	.. Madhya Pradesh	56	J. N. Saikia	.. Assam
19	R. B. Chowdhury	.. Uttar Pradesh	57	H. P. Singh	.. Bihar
20	S. G. Bapat	.. Madhya Pradesh	58	J. C. Bhattacharjee	.. Assam
21	Ishwari Prasad	.. Madhya Pradesh	59	A. M. Khandare	.. Madhya Pradesh
22	P. P. Dharmadhikari	Madhya Pradesh	60	M. S. Saini	.. Bhopal
23	K. K. Hebbar	.. Madhya Pradesh	61	D. N. Deuri	.. Assam
23	R. L. Sud	.. Himachal P.	62	N. B. Shresta	.. Nepal
25	A. K. Ghosh	.. Bengal	63	N. Z. Hussain	.. Assam
26	Dhanajoy Singh	.. Bihar	64	Chittaranjan Sahay	.. Bihar
27	K. C. Sharma	.. Bhopal	65	U. C. Sarma	.. Assam
28	P. G. Parhatay	.. Madhya Pradesh	66	Chandrika Ram	.. Bihar
29	K. M. Srivastava	.. Uttar Pradesh	67	M. L. Gharde	.. Madhya Pradesh
30	R. L. Vijh	.. Himachal P.	68	Gurbax Singh	.. Punjab
31	L. V. Okhade	.. Madhya Pradesh			
32	B. S. Gahlot	.. Rajasthan	LOWER STANDARD.—		
33	D. N. Sen Gupta	.. Bengal	69	B. B. Basnyat	.. Nepal

INDIAN FOREST RANGER COLLEGE, DEHRA DUN

PRIZES AWARDED TO THE 1951–53 COURSE

Serial No.	Name of Prize	Name of Prize Winner	State
1	HONOURS GOLD MEDAL—(To the student who gets the highest total number of marks).	B. S. Rawat	.. Uttar Pradesh
2	FERNANDEZ GOLD MEDAL FOR FOREST UTILIZATION.	B. S. Rawat	.. Uttar Pradesh
3	SILVER MEDAL FOR FORESTRY ..	B. S. Rawat	.. Uttar Pradesh
4	SILVER MEDAL FOR FOREST ENGINEERING.	S .N. Bande	.. Madhya Pradesh
5	SILVER MEDAL FOR BOTANY ..	M. K. Paturkar	.. Madhya Pradesh
6	McDONNEL SILVER MEDAL—(To the best student from the Punjab or Kashmir).	J. N. Dulloo	.. Kashmir
7	WILLIAM PROTHERO THOMAS PRIZE—(To the best Practical Forester).	Rajinder Singh	.. Punjab
8	"INDIAN FORESTER" PRIZE*—(To the best student who has received no other prize).	G. S. Saxena	.. Uttar Pradesh
9	PRINCIPAL'S PRIZE—(To the second best student who has received no other prize).	B. Chaini	.. Madhya Pradesh
10	INSPECTOR-GENERAL OF FORESTS' CUP—(To the winner of the Marathon Race).	M. S. Rajawat	.. Rajasthan
11	HAZARIKA MEMORIAL PRIZE—(To the student who does best in tour examinations).	Rajinder Singh	.. Punjab

* This will be in the shape of free subscription to *Indian Forester* for a period of one year.

After the award of diplomas, certificates, medals and prizes by Shri Rajyapal, the Convocation Address was delivered by Dr. Punjabrao Shamrao Deshmukh, the Hon'ble Minister of Agriculture, Government of India, as follows :—

"I consider it a valuable privilege to be called upon to deliver the Convocation Address of this famous ancient Institute. My pleasure is all the greater to have our friend Shri K. M. Munshi, the Rajyapal of Uttar Pradesh in our midst.

"As an erstwhile holder of the portfolio in the Government of India, which I have now the honour to hold, Sbri Munshi has bequeathed to the Nation many important and original activities. One of the more important of them is the 'Van Mahotsava', which, I think, is very intimately connected with the development of forests, although, ordinarily, the tree-planting is probably confined to non-forest areas. But there should be no reason why plantations in forest areas also should not be brought within its purview. As an ordinary Member of Parliament, I had some occasions of differing from him, but that made no difference to my giving whole-hearted support to every item of his activity which, I was sure, was beneficial for the country.

I am happy, therefore, that there is hardly a single occasion where I am required to preach something different as Minister-in-Charge of Agriculture than what I advised and supported as an ordinary but a very critical Member of Parliament.

"As you will recollect, during the time of the Montague-Chelmsford Reforms, which was the period when I was Minister last in the State of Madhya Pradesh, the Department of Agriculture was a transferred subject but forests were reserved for Executive Councillors nominated by the Governor. In providing thus there was certainly an element of doubt and distrust in the ability of an Indian to look after such important departments of Government but it also showed that forests were regarded as a vital department which required some extra knowledge, care and competence to guide it. I think it is correct to say that we in India on the whole do not fully realize the importance of our forest wealth.

"Here also, the common man unfortunately behaves towards trees in the same way as he does towards the sacred cow. Ordinarily, it is sufficient to worship the cow on a particular day or days and then to have the fullest liberty to persecute it, beat it and ill-treat it to one's heart's content. An old, lame or a blind cow is hardly the concern of anybody, except to see that it does not come very much near to us, enter our compound or damage any crop or cultivation of ours. In the same way, there are a few days on which some trees are singled out for worship. There is a day when the *Avala* tree is worshipped and the *pipal* as well as a banyan tree are also occasionally raised to the position of a deity. But this does not mean that we should treat the trees as a whole with any respect, ordinarily. If one has a dozen sheep or goats, one is at liberty to mutilate as one likes any public tree because the sense of morality ruling amongst the people at the moment is not very high. What belongs to public belongs to nobody or to everybody. Few people care to think with what care and expense it has been reared and what is the purpose with which it has been planted and looked after. The devastation caused by these people, and people who want to clean their teeth at the cost of road-side trees is very extensive. It is a shame that hardly any one stops to think of the results of his wanton behaviour. All this, I firmly believe, cannot be tolerated in free India and ought not to be tolerated. People's conscience and their sense of responsibility as citizens of this Free Nation must be roused and intensive and deliberate propaganda should be directed towards achieving these ends. I have no doubt, if properly explained, there would be an increasing realization of the degree of unpatriotic behaviour we indulge in.

"I need hardly remind you of the antiquity and importance of this Institute. Its foundations were laid three quarters of a century ago by setting up in 1878 a school for training of Rangers. This was then the highest professional forestry course which an Indian could aspire to have. It is noteworthy that this school was brought into existence long before the Indian Forest Act of 1883 was passed, and the first statement of Forest Policy of 1894 was made. The establishment of a school was, therefore, an act of vision and inspiration. The great part that the school and the men trained in it have played in the pioneer work of selecting, demarcating and reserving remnants of the vanishing forests of the country, in protecting and rehabilitating them, in botanical, zoological, physical and silvicultural exploration of the forests and in their ordered management has become a matter of glorious history. To a very large extent our present knowledge of the botany and silviculture of our richly mixed forests and of the technical properties of our wealth of Indian timbers is due to the work of this Institute which has grown out of the old Forest School. The first application of scientific management and scientific methods was made in India. India has long been a leader in tropical forestry, and it is to be hoped that she will maintain this leadership through proper training, sustained research and sound management.

"An event of great significance to forestry circles and to the land economy of the country was the declaration by the Government of India in May, 1952 of a revised Forest

Policy, nearly sixty years after the first policy statement of 1894. The old policy (which we can incidentally claim as the first of its kind in the Commonwealth) had served its turn and grown out-of-date in many ways. Two world wars had occurred since it was adopted. These had led to a great increase in the consumption of timber and other forest products and to the creation of a demand for previously unsaleable and little known timber. War time demands had resulted in many States in a serious depletion of the growing stock through excessive fellings. We had been made painfully aware of the fact that our resources of timber and firewood were limited and inadequate. Timber-using industries had sprung up which have made increasing and specialized demands on the products of the forests. The population had increased greatly and had shown a pronounced trend towards urbanization. Low as it still is, the standard of living had risen. The most important changes of all had taken place in the political field. As the price of partition, the country had been transformed on the 15th of August, 1947 from a semi-colonial dependency to a sovereign democratic State. In the two years which followed, the map of India was repeatedly re-drawn through the progressive extinction of the States and their merger with adjoining provinces or integration into new States. A new Constitution has been drawn up and adopted. While the demands on the products of the forests had shown a substantial increase, the total forest area had, anomalously enough, undergone a steady though slight shrinkage through clearance and cultivation. The productive capacity of the forest had been impaired by abuse and over-use. The evils of erosion, alternate floods and drought had appeared in many parts of the country in varying degrees of acuteness. The menace of the creeping Rajasthan desert had begun to loom large. Clearly the time has come for taking stock of the situation and for laying down a new forest policy to deal with it.

"The new forest policy of 1952 is the product of prolonged consultations with the States and with the leaders of the forestry profession. It is naturally and essentially a compromise between the claims of agriculture, pasture and forestry ; between the demands of the present generation and the interests of posterity ; between local interests and national interests ; between the protective and productive functions of forestry ; and, if I may say so, between the idealistic professional point of view and the realistic requirements of the common man. Forestry is not an end in itself. It is merely a means, - admittedly an important means, of promoting human welfare. The value of a forest is exactly in proportion to its utility as a direct producer of wealth, as a defender of the soil or as an ameliorator of the physical and climatic conditions. Even when we consider the intangible aesthetic and spiritual effects of forests, human satisfaction is the measure of their value. A doctrinaire view of forestry, which tends to grow trees for their own sake and attaches more importance to them than to the people, is wholly out of place in a democratic regime in which the long term interests of the people are paramount.

"With the extinction of private ownership of forests that has taken place (or is taking place) in most States, Indian forestry may be said to be a completely nationalized industry. This development will undoubtedly make for better management, increased forest production, a fuller realization of the indirect benefits of forests and speedier rehabilitation of forests which private management had left in varying stages of neglect and degradation. It will simplify the enforcement of a uniform forest policy in the States. All this may fairly be regarded as making for national progress. Yet, in a sense it may perhaps be said that the practice of sound forestry has become a little more complicated, if not, indeed, more difficult, in the new set-up. In the old days the Government of India exercised direct control over provincial forest administrations ; later under the Montague-Chelmsford reforms the control devolved on the Provincial Governments in a large measure. The bureaucratic paternalism of those days is now gone. While it lasted, it was comparatively easy for the professional forester to satisfy the bureaucrat

of the soundness of his proposals and get them accepted. Forestry is now exclusively a State subject in our new Constitution, and the sources of power have shifted to the people. This has given rise to a double problem. It has become necessary for the Forest Officer to go out among the people and gain acceptance and support for the restriction and regulation which are inevitable in sustaining forest yields. He must now not merely practise forestry in his forest fastness under the protection of the Forest Act, but take his forestry to road-side avenues, and village lands, and help to grow trees on every bit of spare land. He must help develop village industries based on wood or other forest products. He must satisfy the people that he is interested in their welfare and that his duty is to help to rebuild the village economy and not merely to police the forests. In the new Order, more than ever before, the goodwill and support of the people is worth far more for the protection and management of forests than peremptory bureaucratic fiats, however sound and well-intentioned.

"The second problem is that of securing co-ordination of forest policies and forest practices at the level of the States which are autonomous in forestry matters. In the United States, which is a country of comparable size, the Federal Government owns the greater part of the public forests, and, consequently, there the adoption of a uniform forest policy presents little difficulty. In India, however, the Central Government has no forests of its own. The forests belong to the States and are often important sources of State revenues. The risk of divergent and conflicting policies being adopted in different States under local popular and economic pressure is, therefore, a very real one. In a geographical unit like India, forestry ought to be one and indivisible. A case can no doubt be made for vesting certain minimum constitutional powers of co-ordination and control of State forest policies in the Central Government. But the fact remains that under our Constitution, the Centre does not enjoy any such formal powers. This does not, however, mean that the Central Government can afford to divest itself of all responsibility for maintaining technical standards of forest administration over a quarter of the land surface of the country, for ensuring that national interests, such as, for example, the supply of timber for purposes of defence and communications, are not jeopardized by the over-stressing of local or regional interests, for the preservation of the physical and climatic features of the country, and for the protection of the great river systems and river valley projects and of the soils of the country. It means, on the contrary, that the role of the Central Government in Indian Forestry has become even more important and indispensable than before, and that in discharging its functions it must now use methods of persuasion and influence and sometimes of subsidy where formerly it could order and direct. Here, again, the democratic process has to be applied of securing concerted action through the consent and co-operation of the constituent units. This is inevitably a slower and more difficult method, but in the long run, I hope, it will yield more stable and satisfactory results.

"The task of securing co-ordination at the professional level is rendered easy by the fact that every Forest Officer in the country (except the rapidly diminishing element of I.F.S. Officers) has been trained at this Institute which is thus linked to the State Forest departments by almost filial ties. This is a national Institution not only in the formal sense of being a Central Government Organization catering for the needs of the States in Forest Education and Forest Research, but also in the special and intimate sense of being an active instrument in the integrated development and management of the country's forests. It sets the standard of forestry for All-India.

"At the political and governmental level, integration of forest Policy is sought to be secured through the newly constituted Central Board of Forestry composed of Ministers-in-Charge of Forests in the States. The proper functioning of this Board is of cardinal importance to the progress of Indian Forestry. The Board was set up in 1950 and has already met in May, 1951. The next meeting of the Board will be held here in June next when important matters of policy will be discussed.

"In one respect, there has regrettably been a slackening of the close bonds that have in the past existed between the Forest Research Institute and Colleges and the State Forest Departments. A number of Research posts and all the instructional posts have always been manned by Forest Officers borrowed from the States. In recent years, it has become increasingly difficult to get men of the right type from the States for filling vacancies here. The situation has become so difficult that it has become necessary to resort to the expedient of setting up a Central Forest Service. Orders constituting the Service are expected to be passed soon. Since the normal flow of officers from the States to the Centre has thus unhappily ceased, it is to be hoped that a new type of bond will be developed by the reverse flow of Central Forest Officers with specialized experience to the States for undertaking special jobs, especially to those States where organized Forest Departments are of recent origin. The essential object to be aimed at is the maintenance of close liaison between this institution and the State Forest Departments.

"The need for the Forest Officer to emerge from his forest reserves and take his forestry where the people live and toil has already been mentioned. The idea that Forestry is a science to be practised exclusively in areas legally declared as forests is an out-worn one. In the sense of growing trees where they are most needed, the time has now come to apply silvicultural knowledge for growing trees outside the forest properly so-called, whether it be for creating farm forests on village waste lands, for growing wind-breaks to protect fields and orchards, for fodder, for shade or for soil conservation. The Planning Commission has attached great importance to soil conservation work and has allotted two crores of rupees for this work. I trust that the Forest Colleges here will take note of this and plan their courses in such a way as to fit the men passing out of them to undertake the important and difficult work of growing trees outside the forests.

"In view of India's interest in forestry and her long experience of tropical forestry, the Government of India extended an invitation to the Food and Agriculturel Organization to hold the next Session of the World Forestry Congress and the Tropical Forestry Congress in Dehra Dun. Our invitation has been accepted and a Joint Session will be held here late in 1954 or early in 1955. I am sure we shall benefit greatly from the deliberations of the leaders of Forestry from all over the world and I hope that India's own contribution to the discussions will not be a negligible one.

"I have taken longer than I expected, but I felt that all the points that I have touched required to be emphasized. All that I need now do is to offer my heartiest good wishes to those who are on the verge of leaving this great Institute, and are likely to enter upon some career or the other. In doing so, I would like to remind them of the critical nature of the times in which they are going to enter life. The Nation has chalked out a Five-Year Plan, and I have no hesitation in saying that it is a National Plan in every respect. It is a National Plan because the authors have given every consideration to every possible point of view that was urged before them. Such a Plan was necessary because we have all decided to build a New India on old foundations, suitably modified. The task cannot be accomplished unless we release new energies and bring to bear upon it a thoroughly new outlook and renewed enthusiasm. We are behind many nations in many ways. But no deficiency in our national life is so vital as that of national character. I would, therefore, wind up my speech only by giving one small bit of advice, not only to those who are going out of the Institute, but also to those who are coming in. I would not like to say that some others also may benefit by it. That advice is that they should never give second place to Truth. I feel it necessary to impress especially on the minds of our young men the value of Truth and the determination not to resort to falsehood under any circumstances. With the experience of the whole of my life I can say that, however elementary the advice, I can assure you that it saves one innumerable

difficulties in life. If one resolves that under no circumstances he will tell a falsehood, this one small resolve will make him behave with utmost rectitude and honesty. Because, before acting in any particular way, let him pause a little and think – if he were to act wrongly, and if he were asked to say what is the truth, would he choose to lie ? If he is determined not to tell a falsehood, I am sure he will not behave in a way that will drive him to resort to untruth. I think these few words would convince you why Mahatmaji gave, of all other virtues, the highest place to Truth. I feel fairly certain that you will not forget these few words of advice of mine, and thus assist yourselves to behave in such a manner as to be of the highest benefit to yourselves and of the greatest service to the Nation which all of us have the good luck of being born in.

"Lastly, I thank you for giving me this honour of delivering the Convocation Address this afternoon and also thank the Rajyapal of Uttar Pradesh and Mrs. Munshi for having graced this occasion".

The Convocation Address was heard with rapt attention by those assembled and its end was signified by resounding cheers.

Thereupon Shri M. D. Chaturvedi, I.F.S., Inspector-General of Forests, made the following citation regarding Shri Rajyapal in connection with the presentation of the miniature of *Vana Mahotsava* Shield to him.

"Shri Rajyapal, Minister for Agriculture, Shri Ranganathan, Ladies and Gentlemen,

"It is my proud privilege this evening to address myself to the aesthete and the artist, in Shri K. M. Munshi and not the Governor of Uttar Pradesh ; to the man of letters and culture and not to the former Minister of Agriculture.

"In doing so, it is necessary to declare that in this Hall haloed by the sanctity of baptism of generations of Forest Officers, we claim for our remarks the same sort of privilege as they do in that less illustrious House at New Delhi. As a matter of fact whenever I have to cross words with a man of distinction like our distinguished Chairman I usually resort to the ingenious device of inviting him to this Hall on this day, and have my say without fear of transgressing the dictates of decorum.

"Adverting to Shri Munshi, I had heard of him, I had read of him, but I had never met him. How well I remember the occasion when I saw him first ; when this Great Little man immaculately dressed in his white homespun walked into the Committee Room to preside over our deliberations. I must confess his restless alacrity made my heart miss a beat.

"While various items of the agenda of the meeting were being disposed of by Shri Munshi in his inimitable manner, I sat taking the measure of our New Minister. I made the amazing discovery of a hidden transmitter in Shri Munshi, pulsating with radiating waves. Please do not be startled by the extravagance of my simile. It was long time later that I learnt to my surprise that Rajaji compared Shri Munshi to an internal combustion engine.

"Instead of applying myself to the proceedings of that meeting, I toyed with the idea of determining the wave length of the transmitter I had perceived in Shri Munshi. For, my own item, thanks to the Convener of that meeting, was considered so unimportant as to be listed last ; the subject was the annual tree planting day, a dull humdrum affair requiring no more than routine action.

"When my turn came to tune-in the transmitter, I pointed out that pointers issued by the Centre on the subject were rather pointless. I stressed the need for arousing mass consciousness against the insensate destruction of trees, – the silent sentinels which guarded the Mother Earth. I pleaded for the resuscitation of the green glory to our sun-scorched land. I worked myself up to fever heat, and as I was striking hard I saw the sparks on the anvil,

the glow in Shri Munshi's eyes. My task was done. I had found my transmitter; I had fired the imagination of Shri Munshi.

"What Shri Munshi did with that rough hewn idea is too well known to bear any detailed description. I had asked for light. He lit a haystack, supplying both light and warmth. He edified the humdrum tree planting day to the status of a National Festival; he gave it a name: *Vana Mahotsava*; he haloed it with the sanctity from scriptures. Shri Munshi conducted a whirlwind campaign in the press, from the pulpit and from the platform. He fired the imagination of the people and provided the inspiration for the populace. He planted trees at Kanchipuram, the sacred temple in the South; at Vrindavan, the scene of Krishna's songs and toil; at Dehotsarg where Lord Krishna shed his mortal coil; at Nizam-uddin the *dargah* of a Muslim saint; at Rajghat commemorating the Father of the Nation. The entire country-side rose to a man; the youth of the land were likewise inspired to lend a helping hand. Soon, Shri Munshi's message reached beyond the confines of our shores. I received quite a fan mail on Shri Munshi. At Rome, he presided over the biggest tree planting ceremony ever witnessed by the Romans at which 64 nations took part. On that occasion Shri Munshi excelled himself. He delivered the finest oration, not a syllable of which was understood by anyone among his audience. For, he spoke in Hindustani our national language which no one except Mrs. Munshi and I understood. India also sponsored a resolution on the World Festival of the Trees at the F.A.O. Conference in Rome.

"To inculcate a spirit of emulation, Shri Munshi instituted 20 State shields and 4 All-India shields to be awarded for the best effort during the celebration of *Vana Mahotsava*. Although, during the last 3 festivals, millions upon millions of trees have been planted throughout the country and abroad, it is not the number of trees which matters. What to my mind is of the greatest consequence is the idea implanted in the minds of people.

"As a measure of the gratitude of the *Van Premi Sangh*, which incidentally Shri Munshi founded, as a token of appreciation of his himalayan efforts, I take this opportunity of requesting Dr. Deshmukh to present this miniature shield, a faithful replica of the shields he instituted. I sincerely trust he will do us the honour of accepting this humble tribute from the men of the trees".

After this the Hon'ble Minister, presented the shield to Shri K. M. Munshi, Rajyapal, Uttar Pradesh. After accepting the shield, Shri K. M. Munshi, Rajyapal, made the following interesting speech:—

"I need not say how happy I am, once again, to visit this great Institution and preside over its Convocation. I am all the more grateful to you, Sir, for presenting me with a souvenir replica of the competition shields which were inaugurated for planting trees during the *Vana Mahotsava*. I shall cherish this Shield as a precious memento. It will remind me of the vast enthusiasm which has been generated in this country for planting trees.

"The figures that have been given of the achievements of *Vana Mahotsava* during the last three years, and the organized efforts that are being made for soil conservation, for the arrest of the Rajasthan Desert and the implementation of the New Forest Policy, are happy auguries for the future.

"It is necessary that in order to gather the harvest of the work of soil conservation, there should be a soil conservation service in this country. We have foresters; we have agricultural experts; we have biologists; but a soil conservator is something of all the three; he is also something much more. He is a technician of the soil, who co-ordinates the efforts of all. He is the pundit of land transformation, and in view of our programme, it is essential that we should train up such experts.

"Our Five-Year Plan has rightly emphasized the need for soil conservation. The Plan envisages progress in many directions ; food production, community projects ; hydel works, building programme, industrial development. We are going to have more buildings, ships, factories, more literacy and consequently more demand for paper. All this implies a greater demand for timber. Have we estimated the timber required during the five years of the Plan and the continuously increasing demand as a result of the Plan being fulfilled ? This estimate of our prospective long-term needs of timber is essential ; for it has to be followed by a plan to grow, on a continuous crop basis, the timber requirements of the country. And if that is not done, then at a certain stage, our progressive development will come to a standstill. I hope, therefore, Sir, that under your guidance the Forest Department will undertake not only the work of estimating the requirement, but for planning its supply.

"I am very glad to learn that you are planning for the next *Vana Mahotsava* on a big scale. I have no doubt that this Festival will come to be appreciated as the years go by, and that those who scoff at *Vana Mahotsava* will live to celebrate it.

"As you know, my Government has been tackling the problem of the inroad of the Rajasthan Desert in the districts of Mathura and Agra, and you will be glad to know that at the next *Vana Mahotsava*, it has been decided to concentrate efforts on planting trees in this area. As you know, Mathura had several forests. There was the Mahavan, the Madhuvan and the Vrindavan. Most of these forests exist only in literature.

"Giriraj Govardhan, the famous ridge described as the embodiment of Shri Krishna, is bare. The encroaching desert is only a few miles away and as part of the programme for afforestation of the Mathura–Agra belt, my Government has decided that the 14 miles of hill-side through which thousands of pilgrims who perambulate the Mount every year pass, should be planted with trees.

"To my mind, it is not a local affair ; it is an All-India affair, for Govardhan draws people from all parts of the country every year.

"You remember how in the first *Vana Mahotsava* trees had been planted at the Samadhi of Mahatma Gandhi and at Dehotsarga in Somnath and at Kanchipuram in Madras. The consciousness of all who resort to these sacred places have to be awakened to the fact that for a place to be sacred and inspiring, its association with the glories of nature must be restored. Perhaps, Sir, this year a movement will be set afoot that wherever pilgrims congregate or a festival, whether religious or not, is held, the first duty of the visitor should be to participate in a tree-planting ceremony. I would go further and say that even when an event like a birth or marriage is celebrated, trees should be planted. Then only will the tree-consciousness burn bright in this country ; people stop from mercilessly cutting down trees ; and the imbalance of natural resources will be restored. For, on the basis of the National Forest Policy, we have to have 2,000 crores of trees to restore the cycle of life. It is an astronomical figure, I know ; but we are 36 crores.

"Free India can only justify her ambition of rebuilding the land if all the beautiful spots which once covered the country are restored to their pristine glory, so that all that our poets have dreamt about comes to be realized in life".

Then Shri M. D. Chaturvedi, I.F.S., Inspector-General of Forests, Government of India, proposed a vote of thanks in the following words :—

" Shri Rajyapal, Minister for Agriculture, Shri Ranganathan, Ladies and Gentlemen,

"With your permission, Sir, I should first like to turn the spot light on Dr. Deshmukh. By way of introduction, it will suffice for this occasion to say that Dr. Deshmukh is an Oxford

man who strayed into politics and stayed there without forgetting Oxford or regretting his diversion. Essentially an educationist, and an eminent one at that, Dr. Deshmukh's interests are as varied as his experience.

"He was no stranger to us when he took over the Ministry. He was a member of the Advisory Committee of the Ministry of Agriculture which vetted all our schemes. It was at one of the meetings of this Committee that I had the privilege of meeting him. We were discussing the North Andamans Exploitation Scheme. I was subjected to such crass cross examination and treated to such tiresome tirade, that one of the members, by way of variety remarked "Mr. Chaturvedi, we hope you dont mind our questions. You know we have never been to the Andamans". "For that matter, Sir", I shocked my tormentor with the naive remark "Neither have I". And, this was true. For, by that time I had not been to the Andamans either.

"As a Minister, Dr. Deshmukh evinces an enthusiasm which is highly infectious. He has time for everything : be it preservation of lions or destruction of mice, be it the propagation of his theories on education or the Japanese cultivation of rice. I take this opportunity of thanking Dr. Deshmukh for his tearing himself away from New Delhi where the Parliament is in session, and for his thought provoking address.

"I turn now to my victims of this year, viz., the outgoing officers. It occurs to me that I have acquired a sort of prescriptive right of inflicting upon you a word or two of advice on this occasion. It is easy enough to give advice, but what is not so easy is to stand here, year after year, and compete against myself, without repeating myself.

"Unlike you, I do not stand at the threshold of life, with a rosy future. Nothing is easier than to face one's future, for future is featureless ; it is colourful because it is colourless. What is difficult to face is one's past which is a dreadful reality, an ineffaceable actuality. And, when I assume the role of a Sunday School teacher, I generally delve into my unpleasant past and dish out to you an account of my own lapses and failures, the story of the pits I fell in, the stored memory of the buses I failed to catch. You can benefit from my experience in only one of the two ways : take my advice and condemn it as common place, or fall in the same pits in which I fell and have for me a word of praise. Naturally, my vanity would prefer to see you sharing my faults.

"The expression of relief which you wore last night at your mess dinner gave me the clue to how you must have heaved a sigh of relief at the termination of tests and examinations you have been through. How I hate examinations myself! My reason for hating examinations is not that they examine you, but that they don't. Nothing is easier than to reach the winning post, nothing is more difficult than to keep track of the track you have traversed in doing so. When I took you after a tiger the other day, I told you that it was not the tiger which mattered, but the going after it. What matters is not the quarry, but the chase ; what is of importance is not the trophy, but the race.

"I would like to administer to you a stern warning, a rude shock, lest complacency may overtake you when you enter your career. From now on you won't have a test, but a trial which is worse, – a trial which is all the more inexorable because it is invisible. When you walk out of this Hall, you will enter the Department. Believe me, it is a hall fitted with concave mirrors to exaggerate your defects ; you will play the leading role in a tragic comedy of errors. In conducting yourself through your career, nothing will avail you so much as to err on the side of humility ; nothing will stand you in better stead than the ability to say 'sorry' and mean it. Far too many of our officers suffer from a disease which for want of a better name I describe as 'facitis', – the dread of losing one's face. Since inoculation against this

fell disease is not yet available, I can only suggest a palliative. Whenever you are faced with the dreadful prospect of losing your face, please keep your head, lose your face, go home and look into the mirror. You will make the startling discovery that your face will be still there.

"One last word. It is not given to every one to be bright, brainy and brilliant. Having been denied these qualities myself, I have no use for such people. I cannot help the acute density of my brain just as I cannot help the shape of my bald head which holds it. Without quarrelling with God you can substitute brilliance by diligence, intelligence by perseverance. This is no use wishing for the moon, no use wishing for a wish-bone in place of a backbone.

"Before I resume my seat, I should like to take this opportunity to express my appreciation of the efforts made by our Colleges to make this Convocation a success. On behalf of the Forest Research Institute and Colleges, on behalf of the foresters of India I should like to thank Shri Munshi, Dr. Deshmukh and Shri Vishnu Sahay for gracing this occasion. I will be failing in my duty if I did not express my gratitude to you, ladies and gentlemen for responding to our invitation. I am particularly beholden to the ladies who by their presence have lent exquisite charm and colour to the occasion".

The proceedings came to a close with the calling of three cheers to the distinguished guests by Shri H. B. Joshi, the senior-most student, passing out of the Indian Forest College this year. This was heartily responded to by everyone present in the hall.

PROTECTION OF PLYWOOD IN STORAGE IN GODOWNS AGAINST *LYCTUS* BEETLES BY TREATMENT WITH DICHLORO-DIPHENYL-TRICHLORO-ETHANE (D.D.T.) AND BENZENE HEXACHLORIDE (B.H.C.)

BY P. N. CHATTERJEE, M.Sc., D.Phil., F.E.S.I.,

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I. INTRODUCTION

The results of the experiments on the protection of plywood in storage in factory godowns, carried out during 1947–48 in a factory at Dandeli, Northern Kanara Division, Bombay State, are given here. The insecticides used were D.D.T. (dichloro-diphenyl-trichloroethane) and B.H.C. (gamma isomer of benzene hexachloride). It is shown here that they provide good protection against the chief enemy of plywood, viz., the *Lyctus* beetle.

II. EXPERIMENTS

Species—Plywood made from *semul* (*Bombax malabaricum*) and *behra* (*Terminalia belerica*).

Lay-out—Three separate sets of plywood panels, each measuring 19 × 24 × 1/10 inches, were prepared in January 1948 as follows :—(i) A set of 250 panels was divided into 10 bundles, each with 25 panels and using *semul* for core and *behra* for the faces ; (ii) a set of 160 panels was divided into 10 bundles, each with 16 panels and using *semul* for both core and faces ; (iii) a set of 150 panels was divided into 5 bundles each with 30 panels and using *semul* for both core and faces. Before peeling the logs (which were cut to bolts of convenient sizes to fit in the peeling lathe) the transverse depth of the starchy zone was ascertained at the cut ends by means of the iodine test, and all the starchy veneers (i.e., those with moderate to heavy starch content) were separated from those showing little or no starch. From these 2 lots, viz., the "starchy" and the "non-starchy" lots, the 3 sets mentioned above were manufactured in the factory. Casein glue was used as the adhesive. Each bundle was tightly bound with iron hoops and was sprayed with 2% and 4% D.D.T. and 0·2% and 0·4% B.H.C. (both in kerosene oil) by means of a small "Flit-gun", on the four exposed edges of the panels, which form the vulnerable site for *Lyctus* beetles to thrust the ovipositor deep into the transversely cut wood pores for egg-laying. The remaining two sides (viz., the exposed faces) were ommitted from the treatment on the assumption that they were likely to contain few transversely cut pores where *Lyctus* generally oviposit. The controls were untreated. The treated bundles and the controls were then stacked in the factory godown for natural infection with *Lyctus* beetles ; the godown contained an abundance of attacked pieces to serve as sources of infection.

Observations—The progress of insect attack in the treated and the untreated plywood panels is given in Table I.

III. CONCLUSIONS

It will be seen from the above experiments that spraying the edges of the tightly bound bundles of plywood by either 2–4% D.D.T. or 0·2–0·4% B.H.C. gave full protection against *Lyctus* and *Heterobostrichus aequalis* (powder-post beetles ; family *Bostrichidae*) for 3 to 10 months. It may be stated that the more recent experiments (Roonwal and Chatterjee, 1951) have shown that bamboos in storage can also be fully protected against *ghoon* or *Dinoderus* attack by surface spraying with B.H.C. and D.D.T., especially the former.

TABLE I

Results of treatment of the various bundles of plywood treated with D.D.T. and B.H.C.

Treatment (Date of treatment is given in brackets)	Particulars of plywood	Number of plywood panels in each bundle	Total number of plywood bundles treated	Surface area of each bundle of plywood (whose 4 sides only) sprayed with 200 c.c. of insecticides	Total number of plywood bundles as control (untreated for each days' treatment	INSECT ATTACK: Dates of observations with category of attack in treated and control (untreated) bundles							
						12-3-1948		15-6-1948		20-10-1948		31-1-1949	
						Tr.	C.	Tr.	C.	Tr.	C.	Tr.	C.
2% D.D.T. (13-1-1948)	TBf, BMc	25	2	215 sq. in. (about 1·5 sq. ft.)	2	F	F	F	F	F	*L	F	*M, †L
4% D.D.T. (13-1-1948)	TBf, BMc	25	2	,,		F	F	F	F	F	*L	F	*M, †L
0·2% B.H.C. (13-1-1948)	TBf, BMc	25	2	,,		F	F	F	F	F	*L	F	*M, †L
0·4% B.H.C. (13-1-1948)	TBf, BMc	25	2	,,		F	F	F	F	F	*L	F	*M, †L
2% D.D.T. (14-1-1948)	BMfc	16	2	137·6 sq. in. (1·0 sq. ft.)	2	F	F	F	F	F	*L	F	*M, †L
4% D.D.T. (14-1-1948	BMfc	16	2	,,		F	F	F	F	F	*L	F	*M, †L
0·2% B.H.C. (14-1-1948)	BMfc	16	2	,,		F	F	F	F	F	*L	F	*M, †L
0·4% B.H.C. (14-1-1948)	BMfc	16	2	,,		F	F	F	F	F	*L	F	*M, †L
2%, 4% D.D.T. (15-6-1948)	BMfc	30	2	258 sq. in. (1·7 sq. ft.)	1	..	..	..	..	F	F	F	F
0·2%, 0·4% B.H.C. (15-6-1948)	BMfc	30	2	,,		..	..	..	..	F	F	F	F

Abbreviations:—F, free; L, light; M, moderate; H, heavy; TBf, face of plywood manufactured from *Terminalia belerica*; BMc, core of plywood manufactured from *Bombax malabaricum*; and BMfc, both face and core of plywood manufactured from *Bombax malabaricum*; Tr., treated; C, controls.

* Attack by *Lyctus africanus*. † Attack by *Heterobostrichus aequalis*.

On the basis of the above experiments, the approximate cost* for treating a plywood bundle containing 25 panels, each 19 × 24 × 1/10 inches, whose four exposed sides alone (of surface area 215 square inches or about 1·5 square feet) are sprayed, works out at one to two pies, depending upon the strength of the insecticides used. This cost does not include the cost of labour, and apparatus for spraying.

IV. SUMMARY AND RECOMMENDATIONS

Summary—Experiments to ensure the safe storage of plywood in a factory at Dendeli in the Bombay State are described. Plywood panels, tightly tied up in small bundles, were sprayed particularly on the four exposed edges. The controls were, as a rule, lightly to moderately attacked. Treatment with 2–4% D.D.T. and 0·2–0·4 % B.H.C. in kerosene oil gave complete protection for 3 to 10 months against the powder-post beetles, *Lyctus* and *Heterobostrichus aequalis*.

Recommendations—For protection of plywood panels in storage in factory godowns, tie up a number of them (up to about 20–30 panels) tightly in a bundle with iron hoops, and give a liberal spray to all the 6 exposed sides, of either 4% D.D.T. or 0·4% gamma B.H.C. (benzene hexachloride), both in kerosene oil. These products are available from the following sources in India :—(a) D.D.T.—(i) Geigy Insecticides Limited, Neville House, Nicol Road, Ballard State, Bombay—1. (b) B.H.C.—(i) For the brand "LG 110", Imperial Chemical Industries (India) Ltd. (ii) For the brand "Hexidole", Geigy Insecticides Limited, Bombay (*vide supra*).

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Roonwal, M. L. and Chatterjee, P. N. 1951. Benzene hexachloride as a successful anti-insect prophylatic for bamboos in storage. *J. Sci.* and *Industr. Res.*, Delhi, **10B** (12), pp. 321–322.

* The market price of the insecticides and the diluent (kerosene oil) used in the experiment, and on which the cost has been worked out is as follows :—D.D.T. Tech. pp '75% @ 5/8/- per pound ; gamma B.H.C. (I.C.I.) "LG. 110", 10% @ Rs. 46/4/- per gallon ; and diluent @ Rs. 1/11/- per gallon.

A DISCUSSION ON THE ECOLOGICAL POSITION OF SAL (*SHOREA ROBUSTA*) IN CENTRAL INDIA

BY C. E. HEWETSON, I.F.S.
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SUMMARY

The article discusses the ecological problems of the distribution of Sal in Central India. The main distribution of the sal is probably controlled by climate but within its range the distribution depends mostly on edaphic factors. It is pointed out that no simple explanation in terms of physical or chemical factors is adequate and directs attention to lines of research which might lead to progress.

INTRODUCTION

About fifteen years ago I had planned to write a series of articles on the Forest Associations found in Central India. I wished to start with the less widely distributed and end with the climax. I have always regarded the Mixed Deciduous Forest, without any one dominant species as the climax; and "Teak Forest", Sal Forest, Babul bans and others as edaphic variants. The most widely distributed and constant members of the Mixed Deciduous Forest are various species of *Terminalia* and *Anogeissus* – both belonging to the natural order Combretaceae. With this plan in mind I contributed an article to the *Indian Forester*, 1940 (1) on the Forest found at higher parts of Central India, and in the *Indian Forester*, 1941 (2), I wrote on the Ecology of teak. The next subject was to be the Sal Forest but it was not until 1949 that I was reposted to the east of the State where Sal occurs. In the meantime my conception of what is acceptable as an account of a forest type has widened and deepened and I no longer feel that the older type of ecological article will pass. However, it may be useful to summarize what is known and to discuss the questions which must be answered before we can complete a satisfactory account of the Ecology of the Sal Forests of Central India.

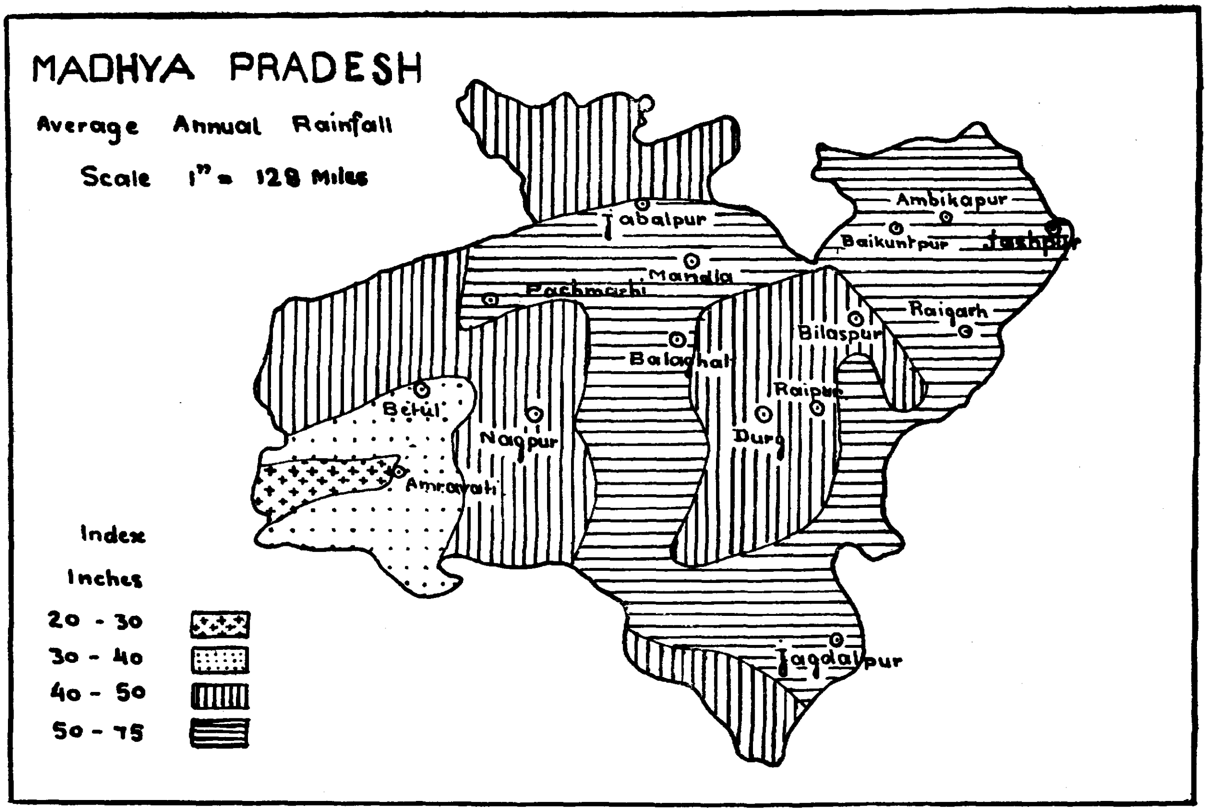
The most authoritative account of the ecology of forest types in India is Professor H. G. Champion's "A Preliminary Survey of the forest types of India and Burma" (3). This was intended to be only a curtain raiser to more intensive investigation and there has been a regrettable lack of progress in the last 16 years. A detailed study of the Sal Forests to the east of Central India is provided by H. F. Moony (4) "A Synecological study of the Forests of Western Singbhum".

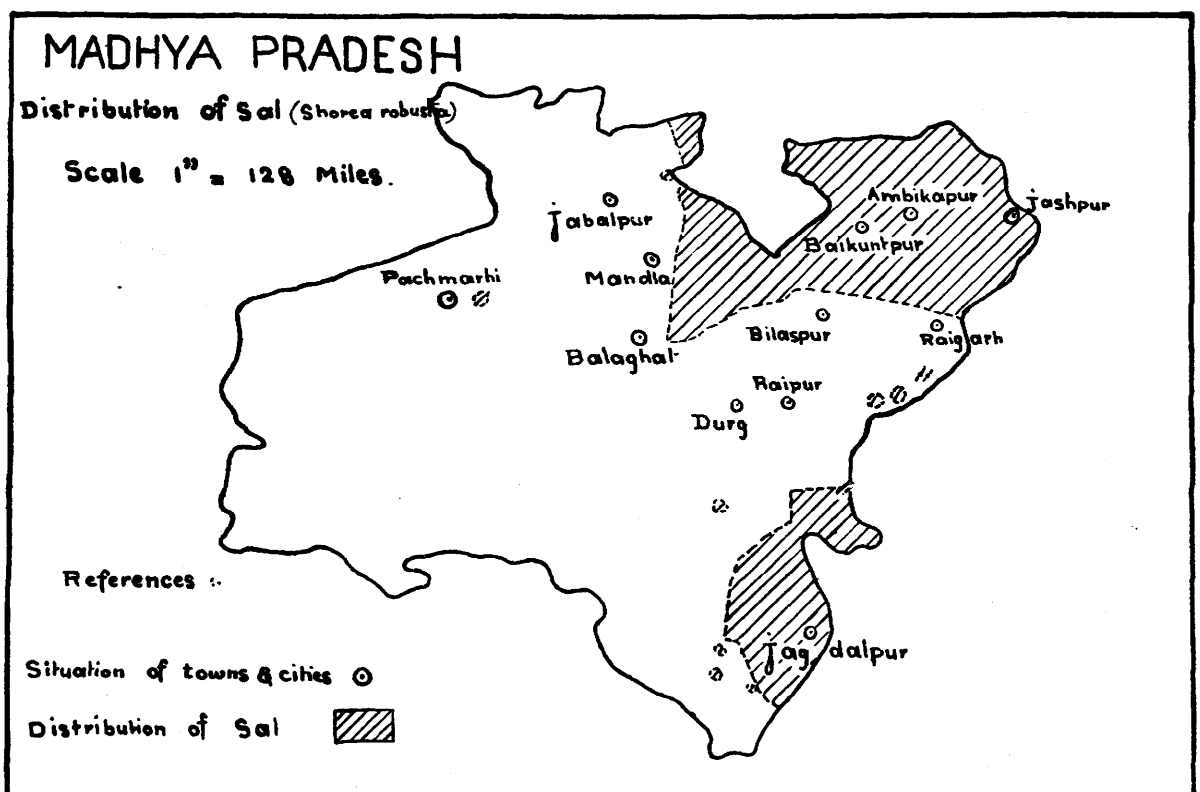
I. THE PROBLEM

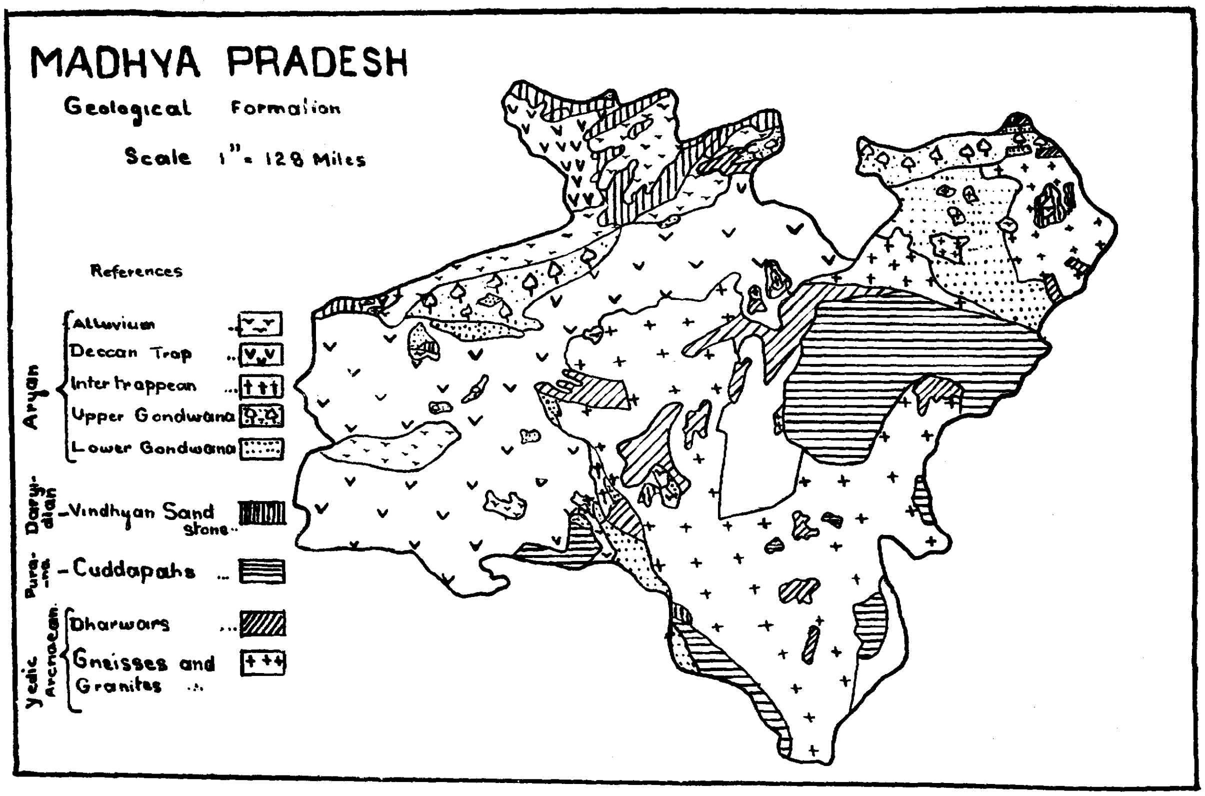
Description of the Locality Factors—The locality factors and present distribution of Sal are set out diagrammatically in the four maps showing (*a*) rainfall, (*b*) topography, (*c*) geology and (*d*) distribution. Rainfall and temperature figures are given in Tables I and II for some stations in the neighbourhood of the tract covered by Sal.

TABLE I.—*Average Rainfall in inches and number of rainy days*

Locality	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total	Remarks
Mandla rainfall	1·45	1·51	0·84	0·70	0·35	8·35	21·8	17·27	6·83	2·60	0·18	0·25	62·14	Mandla W.P. 1949
No. of rainy days	5	5	3	3	2	14	26	14	15	5	1	1	104	Mehta
Raipur rainfall	0·37	0·81	0·71	0·64	0·89	9·06	14·99	14·72	7·69	2·17	0·53	0·20	52·44	South Raipur
No. of rainy days	1	1	1	1	3	12	20	20	12	4	1	1	77	W.P. 1952 Waheed Khan


MADHYA PRADESH
Average Annual Rainfall
Scale 1" = 128 Miles
Jabalpur
Mandla
Pachmarhi
Ambikapur
Baikuntpur
Jashpur
Raigarh
Bilaspur
Balaghat
Raipur
Betul
Nagpur
Durg
Amravati
Jagdalpur
Index
Inches
20 - 30
30 - 40
40 - 50
50 - 75


MADHYA PRADESH
Distribution of Sal (Shorea robusta)
Scale 1" = 128 Miles.
Jabalpur
Ambikapur
Jashpur
Baikuntpur
Pachmarhi
Mandla
Bilaspur
Raigarh
Balaghat
Raipur
Durg
Jagdalpur
References :-
Situation of towns & cities
Distribution of Sal


MADHYA PRADESH
Geological Formation
Scale 1" = 128 Miles
References
Aryan
Alluvium
Deccan Trap
Inter trappean
Upper Gondwana
Lower Gondwana
Darvydian
Vindhyan Sand stone
Purana
Cuddapahs
Vedic Archaean
Dharwars
Gneisses and Granites

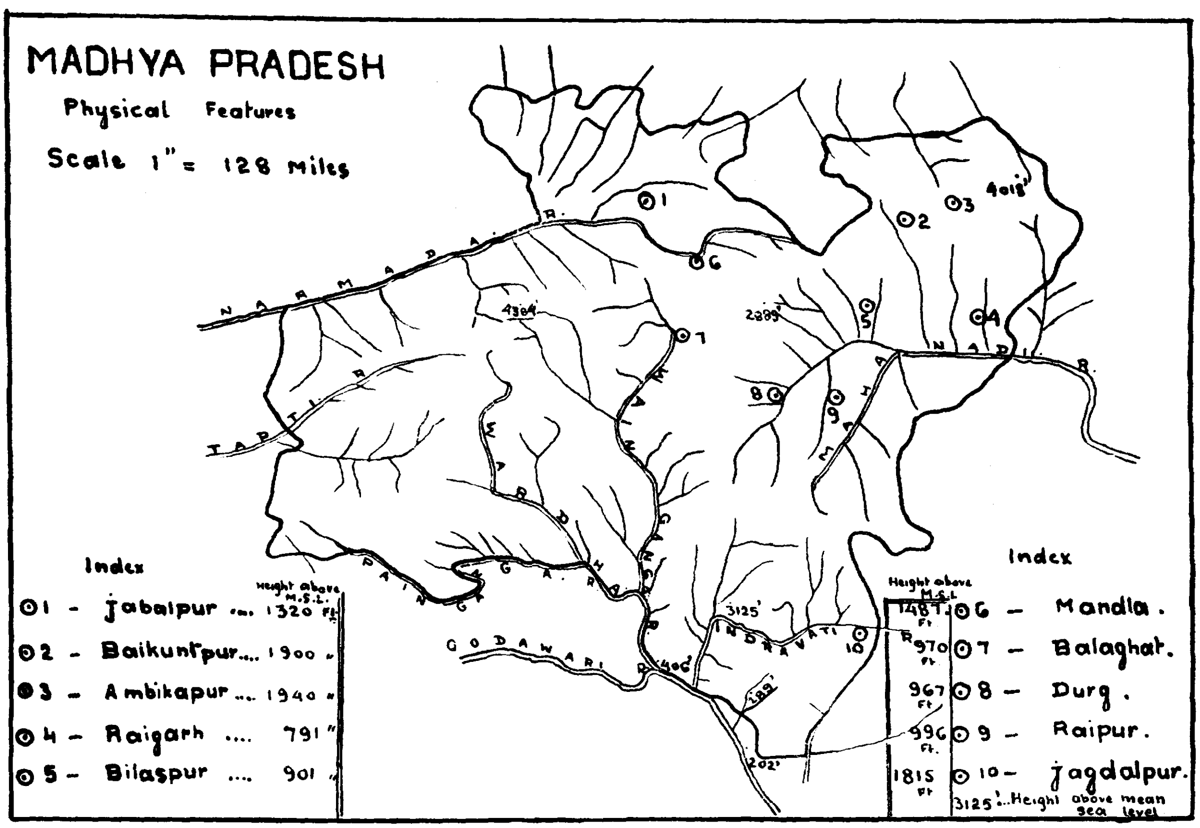

MADHYA PRADESH
Physical Features
Scale 1" = 128 Miles
NARMADA R.
TAPTI R.
GODAWARI R.
INDRAVATI R.
4018'
4384'
2889'
3125'
Index
Height above M.S.L.
⊙1 - Jabalpur .... 1320 Ft.
⊙2 - Baikuntpur.... 1900 "
⊙3 - Ambikapur .... 1940 "
⊙4 - Raigarh .... 791 "
⊙5 - Bilaspur .... 901 "
Index
Height above M.S.L.
1481 Ft. ⊙6 - Mandla.
970 Ft. ⊙7 - Balaghat.
967 Ft. ⊙8 - Durg.
996 Ft. ⊙9 - Raipur.
1815 Ft. ⊙10 - Jagdalpur.
3125'...Height above mean sea level

TABLE II.—*Mean, maximum and Minimum Temperatures (Fahrenheit)*

Locality		Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Remarks
Jabalpur	Max. ..	78·9	83·0	92·8	91·7	107·3	97·9	85·4	84·4	87·7	88·8	84·2	80·0	Mandla W.P. 1949 Mehta
	Min. ..	48·8	52·3	57·2	61·7	78·6	78·8	74·9	74·3	73·2	64·4	53·3	47·3	
Raipur	Max. ..	81·6	86·0	95·2	102·8	107·3	97·9	86·7	85·8	88·1	88·5	83·7	80·0	South Raipur 1949 W.P. Waheed Khan
	Min. ..	55·8	60·1	68·0	76·3	82·1	79·1	75·0	74·9	75·0	69·7	60·6	54·5	

Maximum Temperatures recorded 117°F. Raipur 29–5–35 and 11–6–31.
Minimum Temperatures recorded 34°F. Jabalpur January, 1946.

The following comments will amplify the maps :—

(*a*) *Rainfall, Temperature*—The greater part of the Sal forest lies in the zone which receives an average annual rainfall of over 50 inches. In most of the tract the average rainfall is under 70 inches – except Pachmarhi. The distribution of the rainfall is mostly by the S.W. monsoon ; the rain falls from June to September and for the remaining 7–8 months rain is intermittent with long rainless periods. In some hilly parts, however, as in Jagdalpur, Jashpur (Upaghat), Mandla–Bilaspur showers in April–May are regular. The temperature range is fairly constant throughout. The mean summer maximum in May is 107°F. and the mean minimum in winter in December is round about 50°F. Jabalpur 47·3°F., Raipur 54·5°F. Convection frosts occur, however, in the valleys particularly in Mandla, Balaghat and Jabalpur. Air frosts are rare. The rigour of the hot weather is increased by hot dry winds which blow in the middle of the day particularly in the plains of Raipur. In the hill areas the intensity of heat is modified. The average rainfall, however, is only a partial guide and the amount of rain received in drought years is critical for a tree which is in leaf during the hottest part of the year in April and May. The lowest annual rainfall recorded is 33 inches in Mandla district and 25 inches in Balaghat in 1941. In the hot weather following there was a heavy mortality and many trees became top dead though continuing green below.

(*b*) *Topography*—The altitude at which sal grows varies from about 300 feet above sea-level in South Bastar to nearly 4,000 feet on Dhupgarh on the Pachmarhi plateau. Sal also occurs at over 3,500 feet on the *pats* in Jashpur and Surguja. Within this range sal does not seem to be affected by altitude.

(*c*) *Geology and Soil*—It can be seen from the map that a large number of geological formations occur but broadly speaking the greater part of the Sal is on the old granites and metamorphics or on the Gondwanas. Sal does, however, occur on laterite on the *pats* in Surguja and Jashpur ; on Cuddapahs in parts of Bastar and even on basalts in Mandla and Jabalpur. The soils are also varied. In speaking of soils we are in one of the blanks in our knowledge. Very little has yet been done on forest soils and we know little about their origin or characteristics. In Central India earth movements have been rare and soil forming processes have been acting with little major disturbances for geological ages. The soils now on the surface may have been derived from the underlying rocks or they may have been transported. In some cases what is now the upper soil may have been the B horizon of an older soil of which the A horizon has been eroded away. We find sal now on a wide variety of soils : deep red tropical earths, shallow sandy soils over sandstone, white clays perhaps of lacustrine origin, and thin soils over laterite. We can say that the best quality Sal with top height over 100 feet is generally found on the deep, tropical red earth soils in valleys (Plate I). However, large trees may be found well up the slopes on steep hillsides. Though Sal tends to be less vigorous

on the lighter shallow soils it is a fact that dense continuous sal forest may be found on shallow sandy soils over Gondwana rocks (Plate II) and on laterite caps.

(*d*) *Distribution*—A brief account is given next of the sal forest met with in the Madhya Pradesh. The writer is familiar with all the areas except the Mandla sal forest.

Jabalpur District—Sal occurs in a few places on the north-east. The sal in the Khitoli area is an outlier of the larger area in Rewa. The sal is of III and IV quality and is mostly in the plains. Frost damage is severe. Natural regeneration is good.

Balaghat District—This sal is part of the same block as in Mandla and with the Kawardha forests which fall in Durg District. The sal is of the same type.

Mandla District—Sal covers a large area in the east and south. The most famous areas are in the Banjar valley. Natural regeneration is difficult. Frost occurs. Quality is III and II. Rocks are mostly archaean.

Bilaspur District—The Sal occurs nearly all over except the central plain on Cuddapahs. Bilaspur is a vast area. The sal to the west is similar to the Mandla–Balaghat area and to the north and east is of the Gondwana type of rather low quality sal which is also found in the next 3 districts.

Surguja District—Nearly all the forest is sal and vast areas of sal have been cleared for cultivation. The sal is mostly III–IV, deteriorating to V quality in Korea and Changbhakhsar on the poorer Gondwana strata. Natural regeneration is good. To the east of Surguja there are Archaean hills topped with laterite. The sal has a great affinity to the laterite and grows extremely densely.

Jashpur District—Most of the Sal in Jashpur is on the same type but in the plains in the S.E. the rock types are varied and Sal is discontinuous, of bad quality and does not form gregarious forest.

Raigarh District—Sal is found north of the main railway line on a great number of geological formations. It is generally of bad quality except on some deep sandy soils in Udaipur – probably on Gondwanas.

Raipur District—A broad area of Cuddapah rocks separates the northern block of Sal from the southern block of Raipur, Bastar and Bindranawagarh. The only exception are a few outliers in North Raipur and Phuljhar Zemindaris. In South Raipur and Bindranawagarh the Sal is in the plains and finds the hottest conditions. Frost is almost unknown. Natural regeneration is good. Quality is III to I. The rock is mostly metamorphics, granites, etc.

Bastar District—The greater part of the east, centre and north of Bastar is covered with sal forest. The area is a plateau with higher rainfall and a less severe hot weather than the plains of Raipur. In parts the sal is of the finest quality found in India. Owing to the largely uncivilized aboriginal tribesmen the forests are burnt annually and natural regeneration has little chance. The rocks are Archaean and Cuddapahs. Some of the best sal is on the southern limits of the species.

Outlier—There is an outlier of Sal round the plateau of Pachmarhi in Hoshangabad and Chhindwara districts. Here the rainfall is over 80 inches annually and the rocks are Gondwanas. There is a small plot of an acre or so in Khairi range of Narsimapur about 30 miles east of Pachmaiki.

Before leaving the distribution we may note that in a few places Sal is seen invading the mixed deciduous forest and it is possible that Sal is extending its range. In South Bastar some Sal has been planted by the aboriginal tribes outside the present limit of Sal. This indicates that Sal should spread further south. Another point is that in some Sal forest natural regeneration is scarce or non-existent and it appears doubtful whether Sal can maintain itself.

Summing up we notice two correlations which may be significant.

(i) The Sal forest does not occur west of the line of the over 50 inches/under 50 inches rainfall.

(ii) The belt of Sal in the east is interrupted by the Raipur-Bilaspur (Chhattisgarh) plain which is occupied by Cuddapah rocks, mostly limestones, metamorphosed sandstones and shales. The outlying patch of Sal round Pachmarhi receives a heavy rainfall and is on Gondwana rocks.

This survey provides a superficial description of the occurrence of Sal but there is no depth. Can we at this stage of knowledge in the connected branches of science take the account any further ? As far as the writer knows there is no published work in India which can give us any deeper insight into the distribution of sal.

II. DISCUSSION

Having reached this stage I wished to learn what work has been done on the autecology of any one species in any part of the world. Professor H. G. Champion kindly permitted me to read in the library of the Forest Institute at Oxford, England. In this section I propose to give a short summary of a few lines of research which are to my mind important to the solution of our problem, and which may be of interest to readers of the *Indian Forester* who have not had the same opportunities. In the summary above I have said that there appeared to be correlations between the climate, the soil, and the distribution of the sal. I will give details of some investigations carried out in various parts of the world, which bear on this subject.

(*a*) Rock and soil.

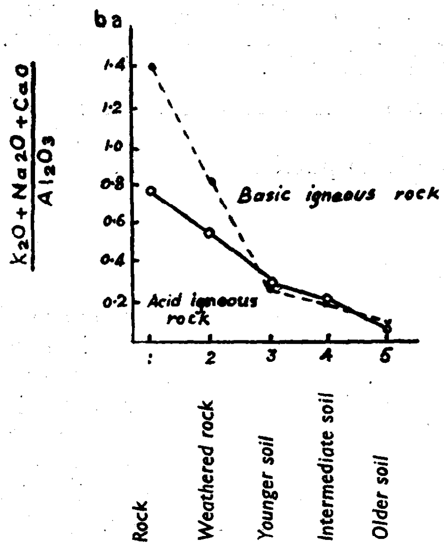
(*b*) The mineral up-take of plants.

(*c*) The effect of different plant associations on soils.

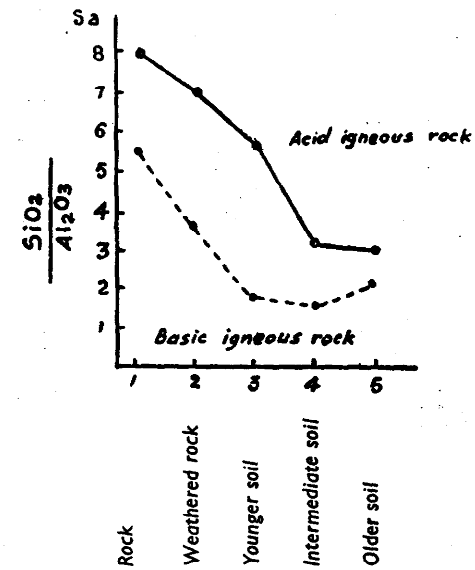
(*d*) The transpiration of plants.

(*a*) *Rock and Soil*—We commonly say sal avoids trap rock and is found on granites or metamorphics, etc. We assume tacitly that the soil is intimately connected with the underlying rock and that different rocks weather to give different soils. This is one of the most controversial topics in Soil Science at the present time. It would make this article too long to give a full account of the arguments. After reading most of the current text-books, I can draw attention to one in particular which sets out the whole argument with great clarity. 'Factors of Soil Formation' (5) by H. Jenny (1941). The main point at issue for the pure soil scientist is whether climate or the "parental material" is the more important in determining the character of the soil. To this may be added the factor of time, which is likely to be more influential in tropical climates - particularly where the surface rocks have been open to weathering for geological ages, and have not undergone a cycle of submergence under the sea. Time operates in two ways : the longer weathering proceeds, the more the easily soluble constituents (bases) will tend to be leached out and the less soluble left, i.e., the silican alumina and ferric oxide. Since all rocks and soils are made up of the same basic minerals - prolonged weathering tends to leave a common residual soil. The second way in which time influences the soil is through erosion (Plate III). This tends to remove soil before the processes of weathering can complete the leaching of nutrients. In seeking an explanation of the occurrence of a tree on one rock and its absence on another naturally the first thought is to analyse the two soils and try and find the difference. This line is disappointing for the plant ecologist as the following results shew. The graphs are taken from H. Jenny's book quoted above and are based on Cobb's Paper on Soils in North Carolina (6). He analysed soils over acid igneous rock and basic igneous rock. The ratio of bases (ba) (K_a O and C_a O) to alumina and the silica/alumina ratio is taken as a measure of the stage of weathering.

Comparison of relative base status of soils derived from acid and basic igneous rock.



Comparison silica-alumina ratios of soils derived from acid and basic igneous rocks.



It can be seen that the soils derived from rocks having an entirely different composition tend to a similar state.

The paper of Cobb is the best I could find in the literature. A second paper by Hardy and Follett Smith (1931) (7) from British Guiana in the tropics is also useful. In this paper soils over five different rocks were compared – basic, intermediate and acidic*. The conclusions were stated to be that in all cases the top-soil is a sandy, acidic, nutrient deficient soil, but the process has been different. The basic and intermediate rocks first gave rise to a primary gibbsitic (alumina) laterite ; this laterite has been resilicated probably by ascending ground water containing soluble silicates. The acidic igneous rocks have given rise directly to kaolinitic earths.

Evidently this line of research by itself will not explain why a tree grows on one rock but not on a second. This method is too gross to reveal the differences to which the plant responds.

(*b*) *The Mineral up-take of plants*—The next line of research which might lead to progress is to analyse the plant to see how much of each mineral has been taken up : we can treat the plant itself as an analyser of the soil. This line at first appears very promising, but it has many difficulties. There are two valuable discussions on the whole literature – (i) Goodall and Gregory (1948) (8), and (ii) Leyton (1948) (9).

(i) First we have to decide the part of the plant to analyse : and at what age ? The place of synthesis of carbohydrates and proteins is the leaves and the mineral content of the leaves is most likely to give an insight into the proportion of minerals essential or optimal for photo-synthesis. The petiole, branches and seeds usually contain minerals in quite different proportions from the leaves. They may store excess minerals. The leaves vary in composition

* Readers should note that the use of the terms acidic and basic rocks is due to one English text-book and is not approved by all geologists. An acidic rock should contain free (i.e., uncombined) SiO_2. A basic rock should have no free silica. J. J. Shand has proposed over-saturated and saturated, which has the advantage that no one can be misled.

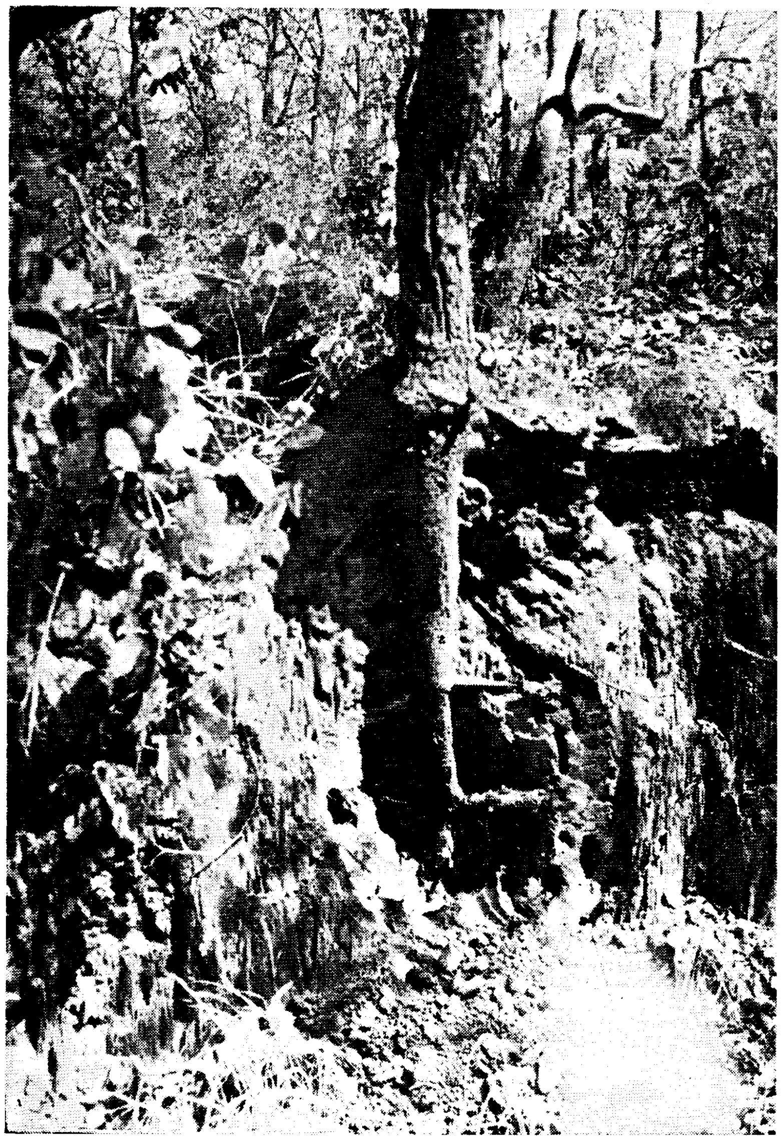


PLATE I.—Deep rooted type of Sal in red tropical earth, Surguja.

PLATE II.—Wind thrown Sal on shallow soil over Gondwana sandstone, Chang Bhakhar

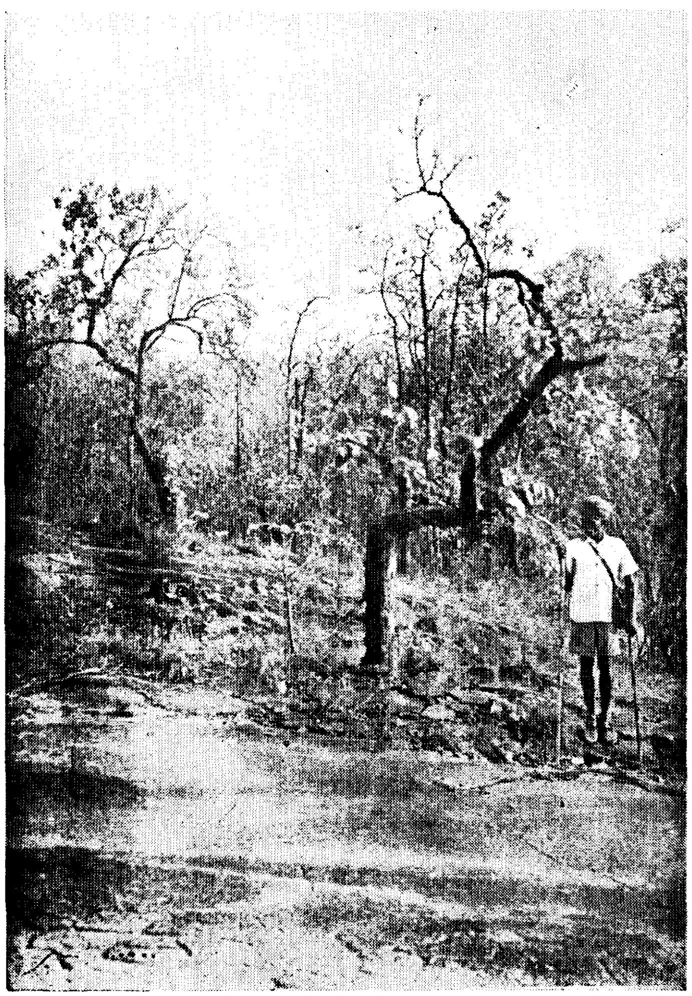


PLATE III.—To shew sheet erosion under pure Sal forest which is burnt annually – BASTAR STATE. The logs act as contour bunds.

←

PLATE IV.—Sal growing on bare Gondwana rock in Raigarh. The tree is stunted and ill-grown but survives.

during their life and their position on the plant. It is desirable to analyse them at the time of their greatest activity ; i.e., not in the juvenile or senile stage.

(ii) The next difficulty in relating the suitability of the soil to a particular plant is that the rate of growth depends on the proportion of the minerals to each other. There is also a a minimum concentration below which growth cannot start. For instance if potassium is below a certain concentration the plant will not grow at all. As the percentage of potassium rises the rate of growth increases up to a point. With further increase there is no further increase in the rate of growth : but if the percentage of nitrogen is increased the plant can make use of more potassium, etc.

(iii) The third stumbling block is that little is known of the role played by the elements in plant physiology. For instance, though potassium is essential for growth it is not known what function it performs. Therefore we cannot draw any precise relation between the quantity of potassium in the soil, the quantity taken up by the plant and the reaction of the plant (its autecology).

(iv) The last objection is perhaps at first sight fatal : our object is to find out why the plant under discussion grows on the one soil but is absent from another. If the plant does not grow on the soil, we cannot analyse the plant ! However, we may learn something from analysing plants from marginal soils on which growth is stunted.

The following notes on H. Lundegardh's 'Leaf Analysis' (10) will give readers an idea of the work done by him in Sweden.

Lundegardh was interested in the process of nutrient up-take by the roots. The first result was that nutrients were not taken up as salts or neutral ion pairs but as free ions, and that in the up-take and transport of ions in the plant the physico-chemical properties of the ions control their speed of movement. Secondly plant growth depends on the concentration of the major nutrients, i.e., potassium, phosphorus, calcium and nitrogen in the leaves.

The next point is that the fertility of the soil (expressed in crop outturn) is not a function of the nutrients present in the soil, but of the quantities taken up by the plant.

From field experiments and plant analysis it was found that there were critical levels for the main nutrients below which plants made little growth. For instance for barley,

If Ca	was below	4·5 mgm.	atoms per 100 gms.
aP	,,	5·75 mgm.	,,
aK	,,	20 mgm.	,,

the plants shewed severe ill effects.

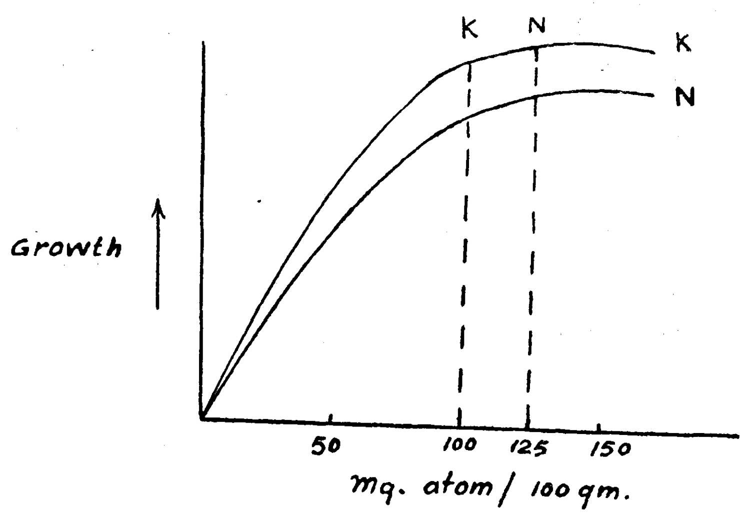
It was also learnt that ion antogonism occurred. The important examples were potassium against calcium and calcium against manganese. That is when K and Ca are both present in the nutrient solution the plant cannot take up so much K from solution as from a solution of equal strength containing Ca in a low proportion. Normally there is a negative potential differences between the root protaplasm and the soil solution. This tends to collect the cations preferentially but obviously this ion migration cannot proceed very far as a high electro-static charge would be built up. The exchangeable ions available at the cell surface are H^+ and OH^-.

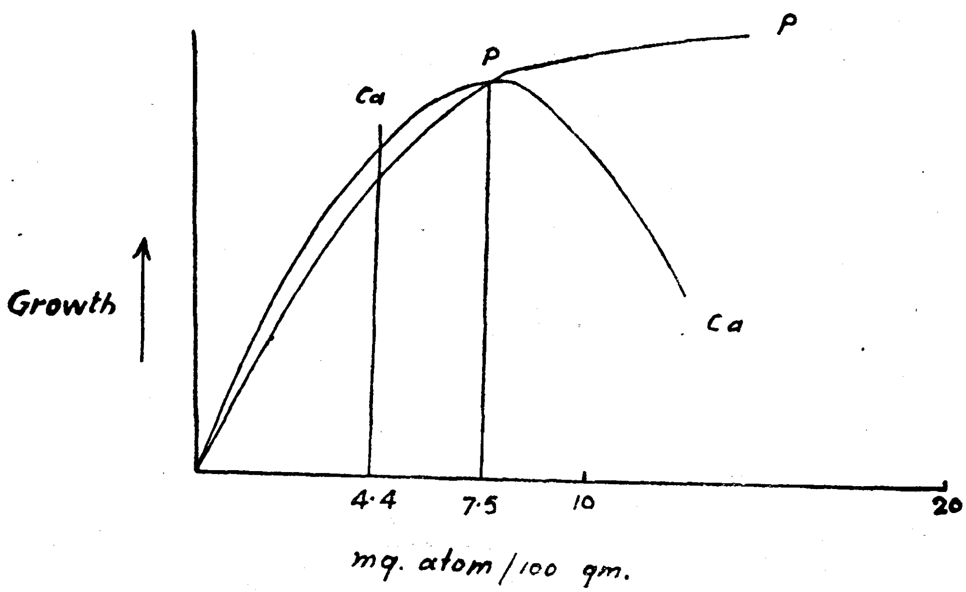
However, anions are also taken up readily and to explain this Lundegardh has proposed a theory of anion respiration. That is energy is obtained from respiration which enables anions to be taken into the root against the adverse surface charge. This theory is not accepted by all but it is proved that living tissue supplied with oxygen behaves differently from dead tissue in taking up salts from a solution.

The leaves are the main site of formation of carbo-hydrate ; and as both the development of the vegetative organs of the plant and the yield of fruits depend on the quantity of carbo-hydrate formed, the leaves are clearly the centre of the functional life of the plant.

Nutrient salts have a two fold action : they influence size and anatomical structure : it is generally agreed that assimilation is constant per unit area of leaf, and so the larger the surface area the more carbo-hydrate will be formed : secondly the nutrient salts influence the chemical composition and hence the intensity of assimilation per unit leaf area.

The graphs below shew the relation between concentration of each main nutrient and growth. When N is constant at 125 mg./atom/100 gm., the effect of increasing concentration





of K on growth can be seen from the graph. Similarly with K constant at 100 mg./atom/100 gm., then the effect of increases in nitrogen can be followed. The second diagram shews the inter-relation of phosphorus and calcium.

These graphs shew that there is a general form of growth response, i.e., near the minimum a small increase in the nutrient produces a big change in the response, but near the optimal concentration the response is small to increased concentration and in the case of calcium growth decreases.

Having obtained these curves it is then possible to use them for measuring the manurial requirements of a crop. This has been done but no one seem to have used this method to decide why a wild plant grows on one soil but not on another. Some analysis of the mineral composition of sal leaves has recently been published by Puri (1952) (11). It is probable that investigations along these lines will provide basic information required to solve our problems.

(*c*) *The effect of different plant associations on soils*—The correct altitude is to regard the parental material, Soil and Vegetation as one system, but the system is not necessarily stable in time. To separate the effect of the Vegetation from other Soil forming factors requires a locality where temperature, rainfall, parental material and approximate time elapsed since the soil was laid down are all identical. Such examples are rare but in parts of the U.S.A. it is believed they are found. In "Factors of Soil Formation" H. Jenny quotes papers by Rost (1948) (12). In Minnesota (U.S.A.) the soil has developed from late Winconsin morraine. In this state prairie and timber exist side by side. Rost analysed the soil under the two plant associations. The results have been condensed by H. Jenny in the table below (page 221 of his book).

Table No. 60 (page 221): Comparison of Prairie and Forest Profiles under conditions of constant environment (Rost)

Constituents	Vegetation	Depth			
		1–6 in.	7–12 in.	13–24 in.	25–36 in.
Coarse gravel per cent	Prairie ..	0·88	1·04	1·87	3·03
	Forest ..	0·52	0·91	1·64	2·15
Moisture equivalent	Prairie ..	29·6	27·7	25·7	25·9
	Forest ..	24·4	20·6	21·9	20·5
Organic Carbon per cent	Prairie ..	4·48	3·19	1·78	0·77
	Forest ..	3·06	1·46	0·81	0·50
Carbon-nitrogen ratio C : N	Prairie ..	11·7	10·7	10·7	13·3
	Forest ..	12·6	12·0	12·4	12·8
SiO_2	Prairie ..	11·9	11·5	11·3	10·3
Al_2O_3	Forest ..	13·6	12·3	11·0	11·1
CaO	Prairie ..	0·22	0·22	0·20	0·31
Al_2O_3	Forest ..	0·21	0·17	0·15	0·17
10 CO_2	Prairie ..	0·16	0·11	0·29	2·02
Al_2O_3	Forest ..	0·24	0·13	0·10	0·08

The main differences are seen to be that organic carbon is more abundant in the Prairie Soil than under timber. The Silica-alumina ratio is slightly higher under forest than under

Prairie indicating that translocation of alumina has been hastened. The Cao/Al_2O_3 values are high for Prairie and low for timber especially in the lower horizons.

Summarizing, the distribution of organic matter is conspicuously different and the translocation of mineral substances is greater under timber. From the data it might be concluded that under equal climatic conditions a deciduous forest cover stimulates leaching and accelerates soil developm nt. In the case of these post-glacial soils in the U.S.A., the time elapsed is only 10,000 to 20,000 years, while in Central India the present surface soils may have been exposed to development for a million years or even geological ages. Soils under forest for such a long period may have a very low mineral content at the present time.

(*d*) *The Transpiration of Plants*—Another line of research is the water economy of plants. How is it that certain plants are what we call "drought resistent" and others require plentiful supplies of water. The most detailed work I could find was done by M. Henrici in South Africa (13) between 1935–45 and later papers could not be traced. Some work on these lines has been carried out also in Palestine. The site of Henrici's work was the South African Koodoo bush and some adjacent mountains. The main conclusions regarding transpiration are :—

1 *Soil Moisture* is basic. When soil moisture falls below a certain percentage, trees react by shedding leaves or go into a dormant period.

2. *Air Moisture*—During misty weather and heavy rain, transpiration is nil. In clear weather transpiration is not proportional to saturation deficit. Other factors also play a large part.

3. *Wind*—Transpiration is always reduced in wind. The stomata usually close as soon as the wind becomes strong.

4. *Temperature and light*—Transpiration starts with the dawn. In nearly all cases transpiration is nil during the hours of darkness. Maximum transpiration is reached in 25/0 of full sunlight. The rate of transpiration usually increases with temperature.

5. *Mid-day Rest Period*—All plants and nearly all associations shew two peak periods of transpiration in the morning and afternoon, with a period of rest around midday. The peaks are not identical with maximum light or temperature. The mid-day depression may be connected with the inability of the roots to supply water sufficiently quickly to keep pace with the rapid rate of transpiration which reaches the peak about 11 a.m. : or it may be an inherent rhythm. Most research agrees that loss of water from the leaf takes place mainly through the stomata. Loss through the epidermis is small ; generally there is a relation between the degree of opening of the stomata and the rate of transpiration, but this is not universal and plants seem to be able to restrict the loss of water even when the stomata are open.

The above results are for plants in South Africa, but no similar work has been done for Sal – particularly during the critical period in the hot weather before the rains. This is a good example of the fundamental research that has to be done by the pure botanists and forest silviculturists in order that there may be progress in Ecology. We want to know at least three groups of facts.—

(i) The layers of soil from which the sal draws its moisture.

(ii) The quantity of moisture in these layers in the critical period in the hot weather.

(iii) The course of transpiration by the sal during the year and particularly in the hot weather.

(*The papers quoted above are selected as illustrative, but it does not follow that similar results will be found under tropical conditions in India*).

III. LOOKING FORWARD

As a field worker I have set out the problem in Part I and sketched in the sort of information available in libraries in Part II. Can it be indicated to the Research Institutes what detailed investigations should be undertaken by them in the future ?

In the absence of any theory and indeed in the absence of any previous body of research in India on the problem, some sort of shot in the dark is perhaps pardonable.

Can we select, out of the observations made in the field, those which can provide a starting line of progress ? I suggest the following :—

1. Sal is a comparatively late comer to the Indian flora and had not had time, before the sub-continent was occupied densely by man, to spread to all the areas where it can grow naturally.

2. The Western and Southern boundary is set by climatic factors which may have been changing even in historic times. The limit of Sal to the dry side is set by a balancing of factors. Sal, despite being nearly evergreen, probably has considerable powers to economize water and to subsist on shallow dry soils. It has not, however, a facultative deciduous habit which would have enabled it to tide over the heat of May and early June in the leafless state. It is an obligate species and cannot delay the new flush of leaves beyond the middle of April in Central India.

3. Sal does not require a high percentage of mineral nutrients to survive (Plate IV). It is often found on the very poor shallow soils derived from granites, Gondwana sandstones and laterite caps. On soils derived from basic rocks it is usually absent. We may also notice that when the A horizon is eroded away, and the B horizon exposed, Sal is very stunted. The B horizon usually contains small concretions and is a horizon of deposit. Ion antagonism may explain these differences. That is we may assume that the minerals are at a very low level in typical forest soils : potassium and phosphorus are indicated as critical. The Sal can obtain sufficient calcium in acidic soils in which calcium is very low but if calcium rises above a certain level, then ion antagonism prevents the Sal obtaining sufficient potassium and/or phosphorus. I mention potassium, phosphorus and calcium, but the determining minerals may be aluminium, iron or even manganese.

I do not argue that Sal never grows on soils with comparatively high mineral content where all essential nutrients are present in quantities above the minimum level : but only the occurrence or absence at the edge of its distribution is controlled by certain mineral nutrients being limiting.

Concluding I advocate research into the water economy and nutrient up-take of the Sal tree as the most likely subjects for progress.

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THE GENUS *DIPTERACANTHUS* NEES IN INDIA

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After the publication of my paper on the Acanthaceae of Bombay I have been receiving a number of questions on the position of the species of *Ruellia* mentioned in the Flora of British India of Hooker. To answer such questions I shall reproduce a few paragraphs from my previous paper and deal with the species of *Ruellia* commonly mentioned in our floras.

"The genus *Ruellia*, to judge from the species attributed to it by Linne in the first edition of Species Plantarum, was a complex one, consisting of 5 American and 3 Asiatic species, of which *R. clandestina* and *R. tuberosa* are the only ones now left in the genus ; moreover these two linnean names are now accepted as synonyms for the same plant, the one commonly known under the name of *R. tuberosa*. Taking *Ruellia* in the modern restricted sense, the genus is exclusively American with *R. tuberosa*, native of Central America, now spreading in India and other countries in S.E. Asia.

"Nees erected the genus *Cryphiacanthus*, which in its original circumscription coincided with *Ruellia* in the modern restricted sense just described ; in his monograph in DC., Prodr. Vol. 11, however, Nees extended the limits of his new genus so as to include a number of non-American plants ; his *Ruellia*, on the other hand, became a totally different genus, containing none of the species originally enumerated by Linne in Species Plantarum, and coinciding with *Hemigraphis* Nees, emend. T. Anders.

"The only species of *Ruellia* found wild or naturalized in Bombay is *R. tuberosa* ; all the other species mentioned by Cooke or by Clarke under the genus *Ruellia* must be shifted to the genus *Dipteracanthus*. The differences between these two genera are here given after Bremekamp :

Flowers in lax axillary cymes ; the cymes sometimes combined in a large terminal panicle. Bracteoles always shorter than the calyx. Pollen grains always 3-porous. Species introduced from America .. .. *Ruellia* Linn., emend. Bremek.

Flowers never in lax axillary cymes ; flowers all axillary, not rarely two or three superposed or in axillary triads. Pollen grains sparsiporous. Asiatic species .. .. *Dipteracanthus* Nees, emend. Bremek.

C. B. Clarke, in Fl. Brit. Ind. 4 : 411, describes the genus *Ruellia* which he apparently considers to be the Linnean genus ; in a short note, however, he adds : "The generic character here given is narrowed to the section *Dipteracanthus* (Genus, Nees) to which section all the Indian species strictly belong".

In the present note only Indian species are considered ; Burma and places further East are left out.

1. *Dipteracanthus prostratus* (Poir.) Nees in Wall., Pl. As. Rar. 3 : 81, 1832; Bremek., Ruell. Mal. Arch. 16 ; Santapau, Acanth. Bombay 24.

Ruellia prostrata Poir. in Lamk., Encycl. 6 : 349, 1804 ; Clarke in Fl. Br. Ind. 4 : 411.

Dipteracanthus dejectus Nees, loc. cit. 82.

Ruellia prostrata Poir. var. *dejecta* Clarke, loc. cit. 412, 1884.

As explained in my paper, it is not possible to keep the var. *dejecta* as distinct from the typical plant, and in consequence both are fused under *D. prostratus* Nees.

2. *Dipteracanthus patulus* (Jacq.) Nees in Wall., Pl. As. Rar. 3 : 82, 1832 ; Wight, Icon. t. 1505 ; Santapau 24.

Ruellia patula Jacq., Misc. Bot. 2 : 358, 1781 ; Clarke 412.

From my experience in Western India, this plant is common in Sind, Cutch, Saurashtra and Rajputana, and rather occasional in the Deccan.

3. *Dipteracanthus longifolius* Stocks in Kew Journ. Bot. 4 : 177, 1852 ; Santapau 24.

Ruellia longifolia (Stocks) T. Anders. in Journ. Linn. Soc. 9 : 460, 1867 ; Clarke 412.

"This is a plant typical of very dry or almost arid situations, with woody, very twiggy stems, and long, narrow leaves, the whole plant being hoary with glandular pubescence.

"For a plant systematist the most interesting part about this plant is the complicated nomenclature under the name *Ruellia* ; T. Anderson in 1867 made his new combination based on Stock's name, but apparently he was in ignorance of the numerous previous homonyms that had been given to several different plants ; T. Anderson's *Ruellia longifolia* (1867) is not the same as that of Richard (1792), nor that of Roth (1821), nor that of Roxb. (1832), nor that of Thunb. ex Nees (1847), nor that of Anderson himself (1864) ; Grisebach ex Lindau in Pflanzenfamilien has added to the confusion by again using the same epithet for a different plant in 1895". (Santapau 25).

4. *Dipteracanthus cernuus* (Roxb.) comb. nov.

Ruellia cernua Roxb., Fl. Ind. 3 : 45, 1832 ; Clarke 413, 1884 (non T. Anders. 1867).

Clarke mentions the plant as being found at *Parasnath*, at an altit. of 2000–4500 feet ; Haines in Bot. Bih. & Or. 674 writes : "Reared in the Botanic Garden at Calcutta from seed sent by Buchanan from Mysore, where the plant is indigenous". Gamble does not mention the plant in his Flora. In Bombay the plant is occasionally cultivated in gardens. Mooney reports it from Jashpur and from the Ranchi District.

5. *Dipteracanthus suffruticosus* (Roxb.) Voigt, Hort. Sub. Calc. 483, 1845 (non Torr., in Bot. Mex. Bound. 122, 1858).

D. sibua Nees in Wall., Pl. As. Rar. 3 : 81, 1832 & in DC., Prodr. 11 : 121.

Ruellia suffruticosa Roxb., Fl. Ind. 3 : 53, 1832 ; Haines 674.

Mooney has observed this plant throughout Orissa, where it is more abundant above 1000 feet.

The question as to the correct name of this plant is somewhat intricate ; the solution depends on the exact dates of publication of Roxburgh's Flora Indica, Vol. 3, and Wallich, Plantae Asiaticae Rariores Vol. 3 ; both books were published in 1832, but which is prior and which is later, I cannot find out with the means at my disposal. The priority of either book will decide which of the two names, *D. suffruticosus* and *D. sibua*, is the correct one. One thing is clear, and that is that Torrey's name, *Dipteracanthus suffruticosus* (1858), is a later homonym of Voigt's name, and, therefore, Torrey's name cannot stand in accordance with the Internat. Code.

6. *Dipteracanthus beddomei* (Clarke) comb. nov.

Ruellia beddomei Clarke in Fl. Brit. Ind. 4 : 413, 1884 ; Haines 674.

According to Haines this plant is common everywhere in Chota Nagpur, and possibly throughout the Orissa Mountains. On this plant Mooney (p. 109) remarks : "It is more of a forest species and is found only under moderate to heavy shade, generally in moister situations than the former" (*R. suffruticosa*).

Ruellia tuberosa Linn., Sp. Pl. 635, 1753 ; Santapau 23.

An erect herb, 25–50 cms. high ; this is an introduced species that is still spreading in Bombay State and in other parts of Western India. Recently I saw it growing wild in Rajkot, Saurashtra. For a number of years I have observed it growing wild in Bombay streets and in other parts not far from Bombay. As mentioned at the beginning of this note, this is the only species that strictly remains in the genus *Ruellia* Linn., emend. Bremek.*

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* The other species of *Ruellia* mentioned by Clarke in Fl. Brit. Ind. do not belong to the present India and are therefore left out of this recension.

FOREST POLICY IN THE UNITED STATES

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Forest policy in the United States has been evolving rapidly during the past century and is to-day still in a state of change. In the great westward expansion and settlement of the United States that reached a peak during the nineteenth century our Government adopted a policy of disposing of its vast domain of public lands to settlers and other private individuals through land sales and land grants. The Homestead Act of 1862 and the Timber and Stone Act of 1878 were outstanding examples of this policy of transferring public resources to private ownership. While our early land laws were generally designed to foster family size farms and other small holdings, at the same time they also favored the acquisition of vast private holdings in the hands of railroads, timber companies, and other large corporations.

An opposing policy of major importance – resource conservation – also came into being during the late nineteenth century. This was expressed at an early date in actions in a number of States for forest fire prevention and control. In 1891 a major step was taken in Federal legislation creating a system of national forests from public domain lands not yet transferred to private ownership. Under Harrison, Cleveland, Theodore Roosevelt, and other Presidents a total of 155 million acres of the public domain, located largely in the western United States and Alaska, was set aside in national forests for public administration and public use. There has also been some reverse flow of forest land back to the Federal government during the past 40 years through land purchase and exchange so that to-day the national forests comprise about 181 million acres, located in 38 States, Alaska and Puerto Rico.

Various agencies of the Federal government also administer an additional 60 million acres of forested lands in the United States, and about 270 million acres of other lands ; these Federal areas include mainly lands of low productivity that were passed over during the period when land, timber, and mineral resources were being acquired by private owners. To-day the people of the United States still own one-fifth of the nation's commercial forest land, and a substantial part of the native range. Essentially all the crop and pasture lands are in private ownership.

Along with the growth of interest in public ownership of part of our forest resources, there has developed a number of forest policies designed to promote better protection and management of private forest lands. These include such Federal legislative milestones as the Weeks Law of 1911 which provided for both purchase of national forests in the East and for co-operative fire control on State and private lands. The Clark-McNary Act of 1924 substantially strengthened Federal-State co-operative programs of fire control, tree planting, and educational assistance to private forest owners. In 1928 the McSweeney-McNary Research Act established a nation-wide system of forest research through regional forest and range experiment Stations. The Co-operative Forest Management Act of 1950, preceded by the Norris-Doxey Farm-Forestry Act of 1937, provides for technical assistance to farmers and other small forest land owners.

Supplementing Federal action in the field of forestry has been a rapid development of State forest services and other State and local forestry agencies. Nearly all our States now maintain forestry organizations of varying size and effectiveness to carry out programs for the protection and management of State lands and protection and management services

* Presented at the Sixth British Commonwealth Forestry Conference, Ottawa, Canada, August-September, 1952. (Read by V. L. Harper, Assistant Chief of U.S. Forest Service in the absence of Lyle F. Watts).

for private forest lands. The Federal Forest Service works in close co-operation with the State agencies in these forestry programs on State and private lands.

Mention should also be made of the development of forest industry organizations in the United States, many of which were formed initially to bring about better fire protection on forest land. These industrial agencies have also become increasingly effective in the fields of general forestry education and technical assistance to private land owners.

During the past several decades we have also developed a fine system of forestry schools in the United States to supply the technical needs of Federal and State forestry organizations and, to an increasing degree, the needs of private industry. The first forestry school in the United States was established at Biltmore, North Carolina, in 1897. To-day there are a total of 33 forestry schools in the United States with an enrolment of 5,280 students. These schools have developed primarily as a part of our State educational system, although privately endowed educational institutions have also contributed much to the advancement of professional and scientific training in forestry.

Great progress in forestry has resulted in the United States from the combination of Federal action and accompanying programs of the States, educational institutions, and private industry. Despite this material progress, however, the forest situation in the United States still presents a number of significant problems and policy issues.

FOREST CONDITIONS IN THE UNITED STATES

As background to discussion of specific policies and programs, I would like to mention briefly a few facts regarding present day forest conditions in the United States. Our last comprehensive Reappraisal made in 1945 showed that we faced a number of problems in timber supply. The Forest Service has recently initiated another of its periodic reappraisals of the forest situation which may lead to new views on forest policy, but the general outline of our forestry picture seems reasonably clear.

In the continental United States, one-third of all the land – 622 million acres – is forest land. About three-fourths of this area, or 460 million acres, is considered to be commercial in character, that is, suitable and available for the continued production of timber crops. The difference – 162 million acres – is non-commercial forest land primarily valuable for purposes other than timber production. Additional forests in Alaska total about 140 million acres, although in the foreseeable future only a small part of this vast area seems likely to be of commercial importance.

Notwithstanding the immense land clearing efforts which since Colonial times have accompanied agricultural development in the East and some parts of the West, the United States does not seem likely to have a dearth of land for timber growing. Our forest lands have the potential, under management, of ultimately producing sufficient timber to meet all our prospective needs.

To-day, however, U.S. forests are not growing sufficient timber to meet the present level of drain on timber of sawlog size. Annual growth of all trees 5 inches and larger in diameter amounted to 13·4 billion cubic feet in 1945, which was just about in balance with total drain. In terms of saw-timber, however, the estimated annual growth of 35 billion board feet was only about two-thirds of annual saw-timber drain. The deficiencies in growth were especially pronounced for the larger sizes and better quality trees, and for the preferred softwoods. For purposes of watershed protection our forest cover in many areas likewise is not making the contribution that it ought to be making.

As one of the guides to forest policies, we have set up a growth goal which we believe would be sufficient to meet our potential timber requirements plus a margin for possible new uses of wood, unexpected timber losses, and exports. Our current estimates indicate that we should aim to grow, within the next few decades, about 18 billion cubic feet of timber annually, including about 72 billion board feet of saw-timber. This would mean increasing all timber growth by about 35 per cent over the 1945 level, and doubling saw-timber growth.

The deficiencies of timber growth in the United States, in terms of both present drain and potential requirements, in the main reflects the condition of our timber growing stock. Less than 10 per cent of our commercial forest area – 44 million acres located almost entirely in the West – was classed as old-growth saw-timber in 1945. Second-growth saw-timber stands of variable stocking covered only about one-third of the commercial forest area. Pole-timber and seedling and sapling stands made up 40 per cent, and poorly stocked and non-stocked lands about 16 per cent, of our commercial forest area.

In 1945 U.S. forests still contained an estimated 1,617 billion board feet of saw-timber, or 469 billion cubic feet of all trees above 5 inches in diameter. But these volumes were not well distributed. In the eastern United States the volume of saw-timber growing stock needs to be nearly doubled if potential needs from this region are to be met. In the West, where two-thirds of the total remaining saw-timber is concentrated, the situation is more favorable. But for long-term planning it is significant that three-fourths of our commercial forest land is in the eastern United States, and even old-growth stands of the West are being converted fairly rapidly to cut-over and young-growth stands.

The problem of inadequate growing stock is further complicated by a steady decline in quality of our timber resources. This is evidenced in a lowering of the average size and grade of available timber and by an increase in the proportion of cull trees.

These deficiencies in timber growth and quality are also, of course, a reflection of poor or inadequate forest protection and timber cutting practices. Recent progress in timber management in the United States has been substantial and at an accelerating rate, yet we are still far short of a general level of reasonably good practices. Particularly good progress has been made in fire control and to-day practically all Federal forests in the United States and all but 15 per cent of the 427 million acres of State and private forest land needing protection are under some organized protection system.

In terms of cutting practices, however, progress has not been so good. In 1945 a comprehensive survey of forest management practices showed that on publicly owned lands, two-thirds of the cutting followed good or high order practices – a fairly satisfactory situation. But public holdings account for only one-fourth of our commercial forest land and only 10 per cent of our current cut of timber products. On private lands the 1945 survey revealed widely different situations. On the large holdings of pulp and paper companies and large lumber companies, cutting practices were relatively good whereas on the smaller holdings they were in general poor. The best showing was made by properties of 50,000 acres or more in the South where pulp, lumber, and other wood manufacturing companies have gone into forestry as a business on the basis of the high forest productivity of this region. On these properties over half the cutting was good or better. On the other hand, on small forest holdings, of which there are some $4\frac{1}{4}$ million in the United States averaging about 62 acres in size, only 4 per cent of the cutting was good or better. These small forest holdings comprise mainly farm woods and other small tracts not connected with farms and held mainly by non-residents. They comprise three-fourths of the private commercial forest land in the United States, and they supply approximately two-thirds of our total cut of forest products, including the saw-logs for thousands of small saw-mills and a major part of the pulp wood used by pulp and paper

mills in the eastern United States. Thus these small holdings are the crux of our forestry problem. It is apparent that the general policy which for many years guided our rural development – that as much land as practicable should be in small tracts under the management of individual owners – has and will long continue to have immense significance for forestry.

Since 1945 timber cutting practices in the United States – as well as fire protection and tree planting – have improved, but I believe the gist of the situation is about the same. While our forest policy must continue to be comprehensive in scope, it must emphasize the objective of bringing about better management on small private holdings.

In stressing the timber resource, I do not want to underrate the importance of other forest resources and values. As protectors of watersheds our forests are of incalculable value, and in many areas watershed protection must be the primary aim of forest land management.

Grazing for domestic livestock is another important value that must be taken into account in the management of forest land. In addition to our vast areas of wild native range lands generally devoid of commercial tree growth, we have in the United States much forest range that furnishes significant forage for grazing animals. In our southern and western States are some 350 million acres of forest range. In the South these forest grazing lands are in the main privately owned ; in the West they are mainly public lands.

Throughout most of the United States forest lands are also valuable for their wild-life and as recreation ground. Some forests, not included in our commercial acreage, have been set aside as parks or refuges devoted to these values. In general, however, wild-life and recreation are parts of multiple-purpose forest management.

Thus, our forest lands present variable problems in resource management : such as how best to integrate timber and livestock use, or how to safeguard watershed values which in most forest and range areas are of increasing importance.

The basic requirements of forest policy in the United States then are these : that it promotes the building up of our timber resources to a level of productivity sufficient to meet our prospective timber needs for home use, export, and emergencies ; and that it encompasses other forest resources and values into multiple-purpose program. Several programs have been fashioned to meet these requirements : first, public ownership and management of certain forest lands ; second, public aids to private forest land owners ; and third, public regulation of private forestry practices. In discussing these three classes, I would like to emphasize those aspects of the programs that most directly touch upon the work of the U.S. Forest Service.

PUBLIC FOREST LANDS

As indicated earlier, the Federal government holds title to fairly extensive areas of forest land in the United States, including 181 million acres of national forests, of which about 76 million acres are capable of producing timber of commercial character. In addition 14 million acres of commercial forest land are in Federal holdings other than designated national forests.

State and local government forests, made up largely of remnants of Federal grants plus extensive areas of tax delinquent lands, comprise about 27 million acres.

Altogether public forest lands in the United States thus include about 117 million acres of commercial forest land, or 25 per cent of the total area of such land.

The development of our national forest system has been guided by the principle that government should own and manage in the long-run public interest a significant share of our

forest land and timber in order to assure favorable watershed conditions and to furnish continuous supplies of timber for the nation. From time to time pressures appear to transfer our public timber and other resources to private ownership, but I believe that the public values in these forests is so widely recognized that our national policy will continue to be against any impairment of the national forest system.

Our national forests are managed by the Forest Service of the U.S. Department of Agriculture under a multiple-use program designed to protect the long-run interest of dependent communities and the nation as a whole. Our policies are to grow timber of relatively large size and high quality, to mark trees for cutting in accordance with sustained yield plans, to sell designated timber on the stump and to insure that logging is done in accordance with requirements that insure future timber crops and good watershed management.

Timber is of great economic importance on our national forests, yet in many areas management policies must place water in first place in terms of national values. National forests in the Western States, for example, are so situated in areas of higher elevation that they supply at least four-fifths of all the water for western agricultural and domestic use. The importance of multiple-use on the national forests is also underlined by the fact that in 1951, 30 million recreationists visited these lands for camping, hunting, and other recreational purposes. Protection of these forests from fire, and management of timber and other resources, must, therefore, be geared to an integrated program designed to develop all forest resources in the broad public interest.

The timber on national forests has come to represent a major economic factor in U.S. forestry. The 522 billion board feet of saw-timber on these public holdings represents one-third of the total remaining saw-timber in the United States. Present timber sales now exceed 4½ billion board feet per year, or close to one-tenth of our national sawlog cut. To-day the annual receipts from timber sales on national forests are well in excess of the funds appropriated by the U.S. Congress for cost of protecting and managing the national forest timber resource. We know that the sustained yield capacity of the national forests is substantially greater than the current cut and that this timber yield can play an increasingly important role in our timber economy.

I would also like to call passing attention to the timber resources of Alaska which are of considerable potential importance. Although much of the forest area of Alaska is considered non-commerical in character bacause of inaccessibility and low productivity, there are in Alaska some 5 million acres of "commercial" forest land in national forests, plus an additional unknown acreage in the vast interior. The national forest lands in south-east Alaska have in the past been of importance only for local use but to-day construction of the first Alaskan pulp mill is underway. In the future these forests will undoubtedly play an increasingly important role.

AIDS TO PRIVATE FOREST OWNERS

Our public forest policies during the past several decades have increasingly stressed a variety of financial and technical aids to private forest owners designed to encourage improved forest practices through co-operative action. Since private forest lands account for three out of every four acres of our commercial forests, and about 90 per cent of the current total timber cut, they represent the dominant factor in the Nation's timber economy, both now and prospectively.

In the 41 years since enactment of the Week's Law of 1911 a Federal – State program of fire prevention and control has been extended to all but 63 million of the 427 million acres of State and private land in need of protection. Most of the remaining unprotected area is in the South, a region where small holdings predominate. Protection expenditures on State

and private forest land by the Federal Government, the States, and private owners totalled about 33 million dollars in 1951, including about 9·5 million dollars from the Federal Government. This program is administered by State forest departments aided by the Federal Forest Service. We need further strengthening of our fire protection program, however, to cover all areas in need of organized protection and to lower fire losses on large areas now receiving inadequate protection.

Control of forest insects and diseases has been largely a public responsibility in the United States. Although large sums have been and are being expended for protection against white pine blister rust, pine bark beetles, the gypsy moth, and other pests, losses to insects and diseases exceed losses to forest fires. Since 1947 the Forest Pest Control Act has provided authority for intensified co-operative action by Federal, State, and private agencies to detect and suppress attacks of insects and diseases.

Tree planting in the United States has been expanded rapidly under a Federal–State co-operative program. Since the Clark–McNary Act of 1924, 1½ billion trees have been raised in State nurseries and distributed at nominal cost to farmers and other land owners. Programs of other Federal and State agencies, pulp companies, and other groups have also led to the planting of large areas. But even this expanding program is still not adequate to reforest our non-stocked or under-stocked lands in a reasonable time.

In the field of forestry extension the Federal–State Agricultural Extension Service now has 78 Extension Foresters developing State-wide programs. Other State and Federal agencies, and particularly private agencies such as the American Forest Products Industries, also are encouraging improved forestry through a number of educational programs.

Newest of our measures is a program of direct technical assistance to aid farmers and other small forest owners. We now have 230 "service" foresters in 36 States financed by State and Federal funds to provide aid to private land owners and small processors. Additional technical services to forest owners and operators are provided by other public agencies, by industry foresters, and by private consultants. But it would take some 2,000 foresters to extend adequate service to all counties having significant areas of forest lands in small holdings.

Research in the various phases of forestry is conducted by the U.S. Forest Service through a Federal system of 12 regional forest and range experiment stations and a national Forest Products Laboratory at Madison, Wisconsin. In addition, many State and private research institutions, as well as industry organizations likewise are actively engaged in forest research, much of it in co-operation with the Forest Service. In 1951 Federal expenditures by the Forest Service for forest research totalled $5,250,000. An even greater amount was spent by State, industrial and other agencies, particularly in the field of timber utilization.

Under the Agricultural Conservation program, administered by the U.S. Department of Agriculture, payments are made to farmers for certain conservation practices such as tree planting, fencing of woodlands, fire break construction, and improved naval stores practices.

Other financial assistance to promote forestry has been made available indirectly in a number of our States in the form of special State and local taxation of forest property designed to reduce the tax load or postpone tax payments until the time of timber harvest. The most recent law, enacted by the State of New Hampshire in 1946, substitutes a yield tax for the property tax on all timber and, in addition, provides a substantial reduction of the yield tax for owners meeting specified standards of forest practice.

Forest credit is made available in limited amounts through certain agencies such as the Federal Land banks. But adequate credit is not available for such purposes as consolidating timber holdings or improving forest properties and there appears to be need for a special

system of forest credit and associated forest insurance. I believe we also need to assist co-operative associations in getting established as a means of improving timber management and utilization practices on small holdings.

PUBLIC REGULATION OF PRIVATE FOREST PRACTICES

One of the major policy issues in the United States is the regulation of private forest practices by public agencies. Our system of forest aids outlined above has brought about great improvements in forest practices on private lands, yet on many private holdings cutting and other forest practices are not satisfactory. Recognizing that the public interest suffers from indiscriminate cutting, some 16 States have enacted legislation to require minimum forest practices. Some of the laws on the books are mandatory, some although mandatory do not provide adequately for enforcement, and others simply provide incentives for compliance.

It is my firm belief that sooner or later in the United States we will adopt an effective policy of public control that will insure continued production from private timber land. I do not believe the public interest can be fully protected without public action to establish minimum standards for forest practices as a supplement to other phases of a comprehensive forestry program. The Forest Service has recommended that a State–Federal system be established which would rely upon the States to administer regulatory laws with Federal financial assistance but which would also provide for national standards and for Federal administration in States which request it or which after a reasonable period fail to put adequate legislation into effect.

In closing, I would like to emphasize that in the United States we have adopted a variety of Federal and State forest policies each designed to meet certain problems associated with the ownership and condition of forest lands. Our primary needs are to intensify the several phases of the broad program outlined above and to achieve as far as possible a balanced program for more effective conservation of our forest resources.

THE RICARDO STEAM ENGINE

(A New Power Unit for Rural Development Work in India)

BY BRIGADIER M. H. COX, C.I.E., O.B.E., M.C., M.I. Mech. E.
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1. The National Research Development Corporation of the U.K., set up by Act of Parliament in 1949, has the function of developing inventions and processes which are in the public interest. The activities of the Corporation cover a wide field and include the development of such diverse inventions as the Bailey Bridge, Electronic Digital Computers, Agricultural Machines of special types, Drugs, Medicines and many others. Since the Corporation came into being in 1949, it has dealt with several thousands of inventions and ideas for new processes and has actually taken over the patent rights of about 1,000 new inventions and processes.

2. Some two years ago it was represented to the Corporation that there was a need in India and other Eastern Countries for a small power unit capable of working independently of liquid fuel. The idea was taken up by the Corporation and a development contract for the production of a prototype model of a suitable power unit was placed with the firm of Ricardo in the U.K.

3. Up to the end of the last century the steam engine, in its different forms, was the universally accepted thermal prime mover. The opening of the new century saw the advent of the internal combustion engine, first in its simple form working on the Otto cycle, followed a few years later by engines working on the Diesel cycle, each type with its variations in the four stroke and two stroke fields. Consequent on these developments, coupled with the availability of ample supplies of liquid fuel at comparatively low cost, design and production of small thermal prime movers in the 2 horsepower to 10 horsepower range has, for the past 20 or 30 years, been confined almost entirely to the internal combustion engine.

The trend of invention and development in engine design has resulted in the production of internal combustion prime movers with low weight per horsepower, low fuel consumption, coupled with improved reliability. Apart, however, from being somewhat complicated mechanically, all internal combustion engines of the liquid fuel type suffer from the disability (as for as India is concerned) that their operation is entirely dependent on imported fuel. Added to this is the steady and consistent rise in the price of liquid fuels, the difficulties of supply as development work is pushed further and further afield, and in the not too distant future, a foreseeable world shortage of such fuels.

4. During this period of half a century of internal combustion engine development, the small steam driven prime mover, from the point of view of design and performance, has been neglected, little thought having been given to where it might have stood had development of the small steam engine kept pace with the development of the internal combustion engine.

5. In the search for a "live on the land" power unit the choice fell on the steam engine, the objective set being to produce an engine employing steam as a source of power, but incorporating everything new and up-to-date in internal combustion engine design. The term of reference of the preliminary design specified :—

(1) That for ease of transportation the equipment should be in three units namely :—

(*a*) furnace ;

(*b*) steam generator or boiler ;

(*c*) engine.

(2) That the furnace should :—

(*a*) be of simple design and capable of being made of materials of normal indigenous supply in user countries ; and

(*b*) for the purpose of the efficient raising of steam, be suitable for burning solid fuels such as low grade coal, lignite, peat, wood, combustible farm and industrial waste, and in extreme cases brushwood or jungle grass.

(3) That the steam generator should :—

(*a*) be of such a size and of such characteristics as would not require it to be classified as a boiler within the meaning of the Boiler Acts and Regulations of user countries ;

(*b*) be of simple and extremely robust construction to facilitate economical manufacture on the one hand whilst avoiding the need for skilled technical operation and maintenance on the other ;

(*c*) be capable of generating steam rapidly from "light up" and maintaining the supply of steam required by the engine ;

(*d*) be capable of operating on moderately dirty or moderately saline water, without abnormal erosion or corrosion of internal or external surfaces ;

(*e*) have a water reserve sufficient to provide ample thermal storage to meet the conditions of temporary overload or erratic stoking ;

(*f*) be so designed as to facilitate rapid cleaning externally and reasonably rapid cleaning internally ; and

(*g*) be safe under all conditions of operation.

(4) That the engine should :—

(*a*) be of simple and robust construction to facilitate economical manufacture on the one hand whilst avoiding the need for skilled technical operation and maintenance on the other ;

(*b*) incorporate, to the fullest extent applicable, advances in mechanical design due in particular to the evolution of the small internal combustion engine and in general to improved mechanical engineering technique. This implied amongst other things, totally enclosed crankcase and valve gear to exclude dust and facilitate efficient, carefree and economical lubrication ;

(*c*) be reasonably economical in steam consumption ;

(*d*) be capable of a sustained power outturn of atleast the equivalent of two horses or two bullocks (this being regarded as the standard agricultural power unit of most Eastern Countries) with temporary overload capacity up to 75% ; and

(*e*) be suitable for employment, where necessary through suitable gearing, in the operation of a wide variety of agricultural equipment and cottage industry machinery of the types normally used in rural life in Eastern Countries.

6. An experimental power unit incorporating the above requirements has been produced and tested with satisfactory results. A brief description of the experimental equipment is as follows :—

(1) *The Furnace—*

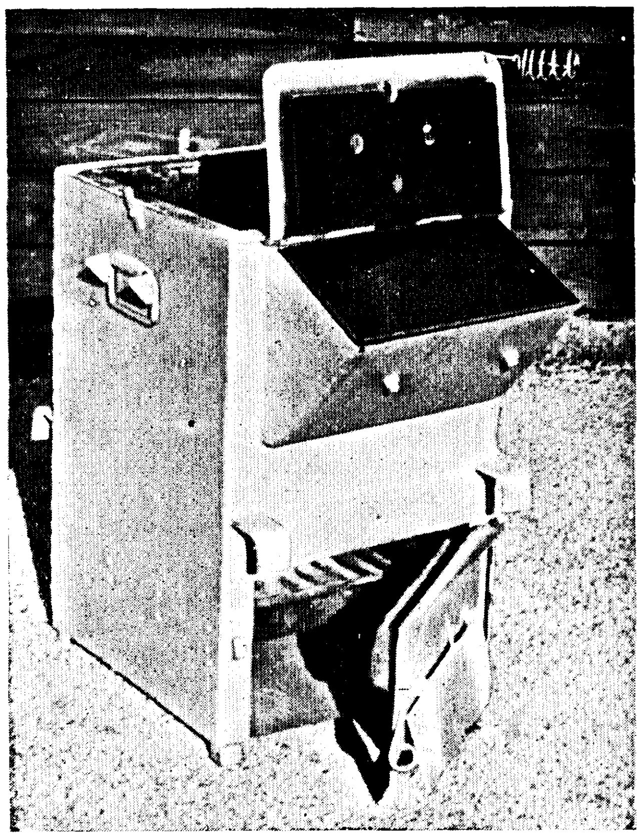
Several experimental furnaces have been built, ranging from an easily transportable type consisting of metal plates faced with suitable refractory material, to semi-static or static types made up of pre-cast fire brick slabs or standard fire bricks, with a metal front apron incorporating feed hopper and draught regulator.

The conclusion arrived at is that, although a furnace of standard design could be evolved to deal with all types of fuel, it is preferable to have two or possibly three type designs to burn most effectively the extremely wide range of fuels visualized.

A feature of importance in regard to furnace design, as established by tests, is that no difficulty is experienced in raising and maintaining a supply of steam at the rate required by the experimental engine, using fuels ranging from coal to green (freshly cut) brushwood.

The time required for raising steam, using natural draught only, is from 12 to 15 minutes. The frequency of stoking varies from about every 30 minutes when stoking with coal or wood logs to almost continuous stoking when burning brush-wood and similar waste.

Any of the contemplated types of furnace can be made with the aid of simple engineering facilities, indeed, except for the fire bars, which should preferably be of cast iron, furnaces can be made up locally with the aid of village blacksmith and bricklayer facilities only.

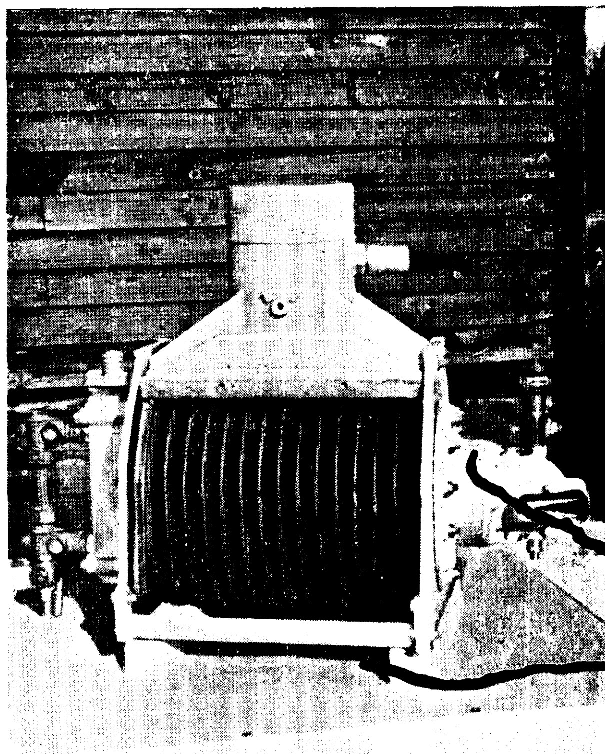


Close-up of welded plate type furnace with firing door, fire grate door and draught regulator open.

(2) *The Steam Generator—*

The steam generator or boiler, built for a working pressure of 150/180 lbs. p.s.i., is of original and unique design. There is a total absence of internal water tubes or fire tubes, thus achieving the acme of simplicity, whilst at the same time ensuring freedom from points of leakage and obviating the frequent cleaning of small diameter tubes. The boiler is kept supplied with water by means of a pump operated by the engine.

Boiler drum and end covers in position →



The main boiler component is a cylindrical drum, thus ensuring freedom from unwanted stresses. The drum is deeply ribbed on the outside for the dual purpose of strength and efficient heat transfer. The material employed is a corrosion resisting aluminium alloy.

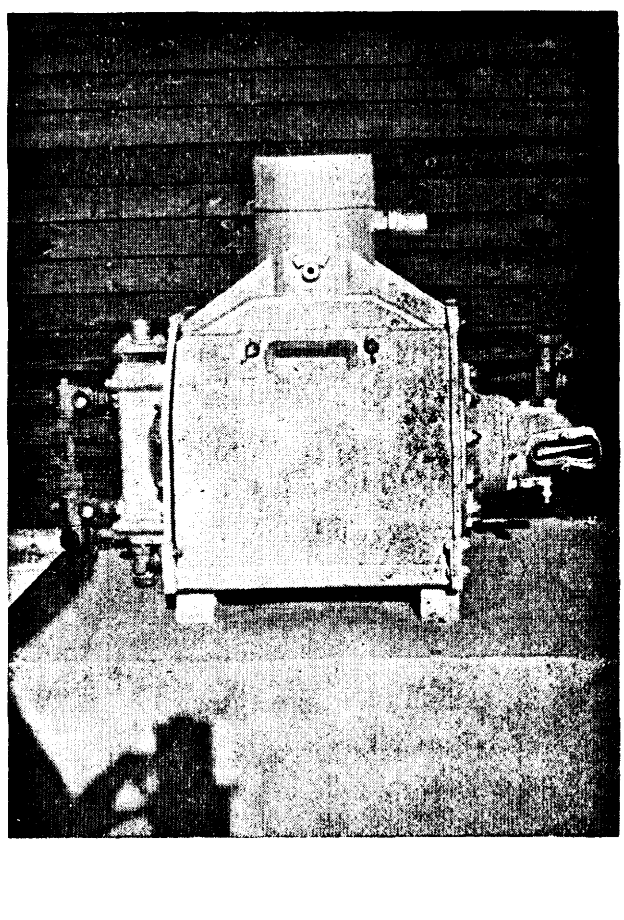
The experimental drums are sand cast but the ultimate intention is to produce drums by die casting.

The drum is closed by two aluminium alloy end covers, secured to either end of the drum by studs. One end cover incorporates the internally situated, float-controlled, feed water inlet valve and an audible pressure release valve. The other end cover incorporates the water level gauge, the blow down valve and the steam outlet to the engine via the superheater.

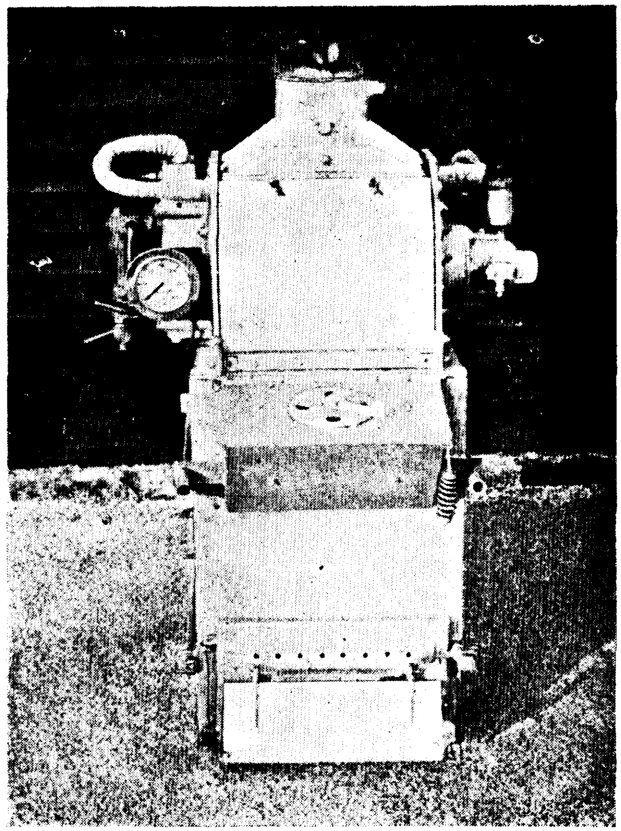
The boiler drum is supported in two light alloy end plates connected at the top by a light alloy bridge piece, which incorporates the first section of the stack. The end covers are easily removable for such cleaning of the interior of the drum (in addition to routine blow down cleaning) as may be necessary.

The sides are enclosed by two insulated covers easily removable for cleaning the exterior of the drum. When closed the side covers fit closely over the tops of the ribs of the drum thus, in effect, converting the rib into a series of fire tubes of roughly rectangular cross section,

Complete boiler assembly →



Close-up of boiler and furnace, front view →



external to the boiler. This arrangement, coupled with the use of an aluminium alloy for the drum and its incorporated ribs, ensures high efficiency in heat transfer. The rectangle formed by the bases of the end plates and side plates forms the connection between steam generating unit and furnace.

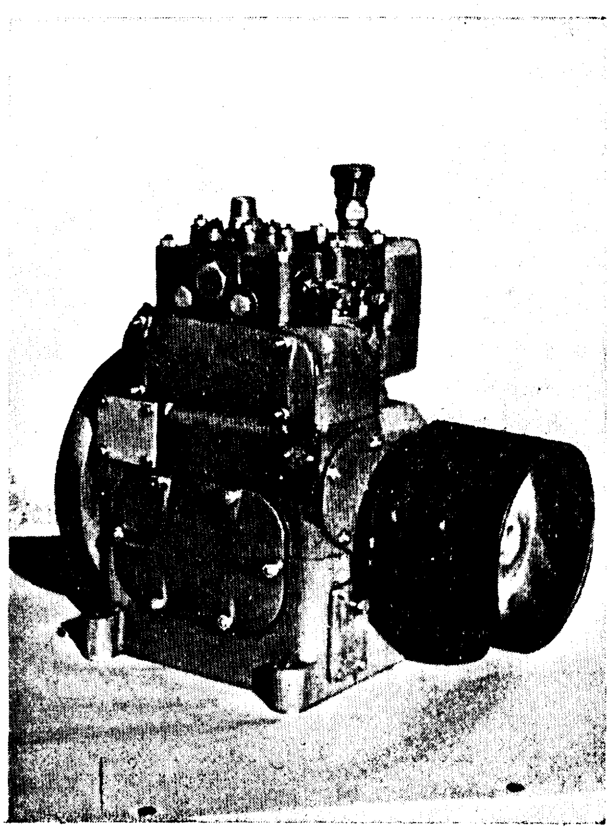
The whole unit, being constructed of light alloy, and designed for high effective heat transfer, constitutes a steam generator of incomparable lightness and efficiency, without any of the complications of tube plates, water tubes, or fire tubes, usually associated with small high efficiency boilers. The fact that most of the components of the boiler can veritably be produced by die casting, with a minimum of machining, is a truly revolutionary innovation in small boiler manufacturing technique.

The complete boiler assembly is mounted over the furnace to form a compact steam raising unit.

(3) *The Engine*—

The engine is a two cylinder Uniflow type with poppet inlet valves and port exhaust, capable of developing 2·6 brake horsepower continuously at 1250 R.P.M. when supplied with steam at 150 lbs. p.s.i., with overload capacity, at some loss of efficiency, up to 3·7 brake horsepower. The engine, including the valve gear, is totally enclosed in a dust proof and water

Engine assembled, driving wheel end →

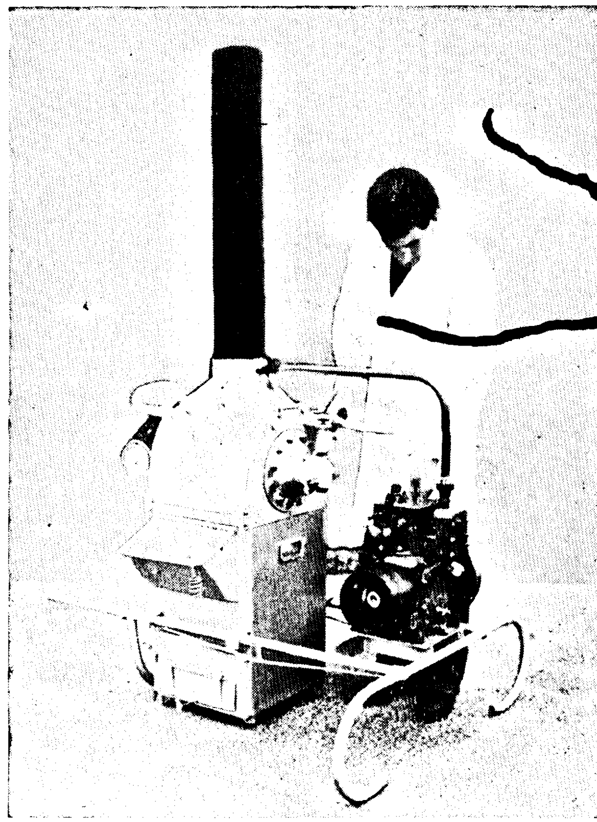


proof casing and lubricated throughout automatically. There are no packed glands and no external points requiring lubrications, in fact from the operation and lubrication points of view the engine has the appearance and characteristics of a small motor car engine.

The engine is light in weight in relation to power outturn. Unlike the small internal combustion engine it is capable of an overload of up to 75%, and its power outturn is not affected by elevation. It has no carburettor or electrical ignition system, no fuel pump or injection control gear, in fact beyond keeping the steam supply going and the daily replenishment of the lubricating oil supply there is nothing requiring attention or adjustment.

(4) *The Complete Assembly*—

The three components, which are transportable separately, can be assembled together quickly to form a complete power unit. Various types of mountings can be used as examples a concrete or wooden sleeper bed for a static installation, a trailer mounting for a mobile power unit, etc. In country where wheeled transport cannot be used the components can be carried quite easily, slung on poles, as porter trade.



View of the complete prime mover on tubular steel mounting.

7. *Useful data* is as follows :—

(1) Steam and fuel consumption.

Steam consumed is in the order of 30 lbs. per horsepower/hour, therefore, at continuous full load of $2\frac{1}{2}$ horsepower, steam consumption is 75 lbs. per hour.

To generate 75 lbs. of steam per hour the consumption of typical fuels is as follows :—

Average quality steam coal, 8 to 10 lbs. of coal per hour.

Low grade (20% ash) coal, 10 to 12 lbs. of coal per hour.

Wood blocks, between 25–35 lbs. per hour according to species of wood and dryness.

Peat containing 50 to 70% moisture, 35 to 40 lbs. per hour.

Consumption of other fuels would be proportionate to the calorific value of the fuel.

(2) Weight of components.

Furnace	..	150 to 200 lbs. according to type of construction.
Steam generator	..	90 lbs. approximately.
Engine	..	80 lbs. approximately.

Note.—The above weights refer to experimental models. It is not expected that the weights of production models will exceed these weights.

8. *Conclusion*—It can be said in conclusion that the N.R.D.C. sponsored Ricardo prime mover offers a truly "live on the land" small power unit, capable of operating with complete independence of imported liquid fuel, and suitable for driving, in the smaller size, the many items of equipment such as irrigation pumps, corn grinding mills, electrical generators, wood sawing machinery, cottage industry type of textile machinery, small printing presses, etc., etc., the employment of which is becoming more and more essential to the ordered development of rural life, particularly in Eastern Countries.

9. *Future development*—Because of the success of the $2\frac{1}{2}$ horsepower engine and its associated boiler, and realizing that a demand may exist for a power unit of somewhat greater horsepower, a design study is being made of an engine and boiler capable of producing 5 horsepower continuously with overload capacity up to 7 horsepower. This will probably take the form of (i) a four cylinder version of the smaller engine, using the same parts except for a four throw crankshaft and a longer crankcase, (ii) a twin drum version of the smaller (single drum) boiler. A power unit of this size would operate tube well pumps of reasonable capacity and drive larger types of machinery than the smaller equipment.

Another useful development, employing the Ricardo boiler, but with a different engine, is a portable steam driven chain in saw. The engine unit fits into the chain saw like the petrol engine of the normal type, steam being fed to the engine through rubber hose, rather like air compressor and rock drill equipment. The engine is designed to run on wet steam so as to avoid difficulties due to condensation. A saw of this type, with its associated boiler, can be taken into the forest and used for felling or dressing timber, the steam supply being maintained by burning scrap wood which would otherwise go to waste.

10. *Fuel Supplies*—The aim in developing this power unit has been to secure independence of liquid fuel supplies, particularly in countries with no resources of liquid fuel, because apart from cost, power for rural development based on imported fuel is dependent on the continuity of fuel supply which cannot, in all circumstances, be ensured.

Many countries without liquid fuel resources have vast reserves of low grade coal, lignite or peat. These fuel resources may be located in certain areas only, but the organized distribution of such fuels should present no more difficult a problem than the distribution of imported liquid fuel.

In some areas where coal, lignite or peat are not available, forest or jungle areas exist, which can be drawn on as a source of supply of wood fuel for power. In many countries there are wide areas of arid land with known reserves of water below ground, which could be tapped by tube well pumping. Indeed vast areas of land exist to-day, unusable for cultivation because of water logging and salt encrustation (due to canal seepage) where systematic tube well pumping is held to be the only means of restoring the land to useful cultivation.

As a long term development plan the growing of wood fuel for power for pumping water for irrigation offers boundless possibilities. The growing of trees in many areas is of importance for the checking of soil erosion, provision of shade and wind breaks and improving amenities generally. With the possibilities of utilizing wood as a fuel for power for pumping, the systematic growing of trees becomes doubly attractive. The committee on the utilization of Solar Energy, set up by the National Physical Laboratory (U.K.) under the Chairmanship of Dr. E. C. Bullard, F.R.S., estimates the possibilities of growing wood as a fuel for power, as a means of utilizing solar energy. The report of the Committee on this particular question reads that, if it is assumed that land to be irrigated requires, during the year, the equivalent of 0·5 m. of water, which must be raised from a depth of 10 m., the known figures for yield, calorific value and efficiency of machinery, show that the amount of land required for growing fuel for the engine driving the irrigation pumps is about 1/50th of the area to be irrigated.

If a factor of 5, or to be even more conservative, a factor of 10 is taken, the growing of wood fuel for power for irrigation is practicable – indeed it is possible to visualize completely self-supporting communities with land irrigated by power units operating on a regenerative home grown supply of fuel, each with a generous margin of irrigated land for growing food or cash crops. Coupled with this would be the inestimable value of afforestation as an end in itself.

WILD-LIFE PRESERVATION IN BOMBAY STATE

BY J. V. KARAMCHANDANI

Conservator of Forests, Central Circle and Wild-Life Preservation Officer, Bombay State, Poona

Introduction—With a view to making better and adequate provision for the preservation and protection of 'Wild-Life' consisting of animals and birds, the Government of Bombay has passed the Bombay Wild Animals and Wild Birds Protection Act, 1951 which is being brought into force very shortly. It is a very welcome and timely move, indeed, since, from experience, it is found that 'game' had virtually disappeared and provisions of the Indian Forest Act for the purpose of protection were inadequate both in regard to scope as well as in punishment of the offender.

The Act is, in other words, an improvement of the Indian Forest Act with wider application, in-as-much-as it extends over the whole of the Bombay State and unlike the Indian Forest Act, is not confined to forest areas only. The Act does not apply to domesticated or other animals or birds which are lawfully captured and kept in captivity, nor is handling of such animals and birds which destroy agricultural crops prohibited.

State Wild-Life Advisory Board—With a view to formulate the Policy and to advice the Government, provision has been made under the Act to constitute 'The State Wild-Life Advisory Board' with the Chief Secretary to the Government of Bombay as the Chairman.

Hunting—Hunting of any wild animal or wild bird is prohibited except under a licence and game has been classified for the purpose as Special Big Game, Big Game, Small Game and Vermin. No licence is required to hunt *vermin*. Unlike the hunting licences issued under the Indian Forest Act, the licences issued under this Act will be valid for the whole of the State and confined to the class of game and number specified therein. The holder of the game licence is prohibited under the provisions of the Act to sell flesh of any game shot by him. Any person who holds a licence granted under the Indian Arms Act of 1878 for the possession of arms for sport or protection and possesses any arms has to register his name and address at the time of the renewal of the arm licence. No hunting licence can be granted unless the person concerned has got his name and address registered under the provisions of the Act.

Dealings in Trophy, Pets—The business of trophy dealer, taxidermist and dealer in pets has been controlled under and in accordance with the licence granted under the provisions of the Act and no such dealer shall buy, sell or offer to sell the meat of any wild animal or wild bird.

Whereas, in regard to the individual licences, they are required to take out "Ownership certificate" of a trophy constituting elephant tusks and mounted heads with masks of Big Game and Special Big Game. Such owners cannot sell the same to any person other than the holder of trophy dealers' licence, nor can export or transfer by gift, sale or otherwise to any other person, be permitted in absence of such ownership certificate. Any game found dead or killed without a licence in defence of life or property or by mistake, shall be the property of the State Government.

Pet and other animals Trapping Licence—The trapping of pet and other animals is also controlled by issue of a licence under the Act and possession of more than six animals or birds in aggregate is also required to be covered by a "possession" licence.

Administration and enforcement of the Act and Prevention, Detection of offences and penalties—For effective control and enforcement of the Act, the Government of Bombay has created a separate department and appointed a Wild-Life Preservation Officer. The Wild-Life

Preservation Officer will be assisted by Game Wardens (both official and non-official) and Assistant Game Wardens for prevention and detection of offences. In addition to the Wild-Life Preservation Officer, Game Officers or any Forest or Police Officers are also empowered to enter, search, arrest or detain any person if there are reasonable grounds for believing that any person has committed an offence against this Act. Any person who commits an offence under any provision of this Act or of any rules made thereunder or commits a breach of any of the conditions of any licence or permit, is liable to punishment with imprisonment which may extend to six months or with maximum fine of Rs. 500/- or with both.

Conclusion—In conclusion, I may be permitted to remark that with all the provisions of the Act, no one, I fancy certainly not I, imagines that this will stop illegal hunting, but this much is certain that it will cramp the style of poachers. Moreover, it gives the Wild-Life Preservation Department a chance to get on with the job without having their hands tied. In the long run, the success of "Wild-Life" conservation must depend predominantly on the completeness with which 'Wild-Life' problems and their implications are known, or on the extent to which public opinion accepts them and, therefore, gives support to the necessary measures of conservation. In this field, more perhaps, even than in most others, it is no use waiting till the offence is committed. The only effective course, as it appears to me, is to create conditions in which its occurrence is reduced to a minimum. This, in my opinion, can best be influenced by education, by information and publicity and by close co-operation between the public and private interests concerned. Without such a background, legislation becomes a dead letter and a cause of apathy among those responsible for its enforcement.

Pathological Note No. 6

NEW AND NOTEWORTHY DISEASES OF TREES IN INDIA

The sap and heartrot diseases of *Eucalyptus maculata* Hook., var. *citriodora* Bailey due to the attack of *Trametes cubensis** (Mont.) Sacc.

BY K. BAGCHEE

Mycologist, Forest Research Institute and Colleges, Dehra Dun

Eucalyptus maculata Hook., var. *citriodora*, Bailey, the lemon-scented variety, an Australian tree now growing practically in all towns of India, was introduced in this country a century ago. Although not a timber tree it has some economic importance, as it contains a high percentage of tannin and also produces oleo-resins from which turpentine, citronella oil and the bases for perfumery oils are manufactured. For this purpose it has been extensively planted in the plains and on the Nilgiris and for fuel in Mercara, Coorg. A fast growing species, it grows into a tall and stately tree in 25 to 30 years and produces a fine effect giving a light shade in parks and avenues. The trees, which initially grow with thin cylindrical stems until they attain middle age and build up a strong bole, are liable to be snapped by tropical storms and hurricanes. The branches are also often broken during storms. The wood is of a soft type and the bark is thin, the trees being susceptible to injuries by severe frost, excessive drought, hailstones, sun and fire scorch. Due to the great heights they attain at maturity, the trees often become a target of lightning.

The trees are attacked by *Ganoderma lucidum* which enters through the injuries in the roots and causes root rot disease. Such trees show signs of die-back in the pole stage. The 'gummosis' disease also attacks Eucalyptus in many plantations in the Nilgiris and in the sub-Himalayan tracts and plains of northern India. The bark is stained initially to a dark brown colour and finally cracks and becomes moist. In the advanced stage a heavy exudation of gum, tannin and other colouring matters takes place for 2 to 3 years till the tree dries up. The disease could not be correlated with any micro-organism and is at present considered as a physiological disease due to some unknown edaphic factors, deficiency of minerals, etc.

Pathology—The sun-scorch on Eucalyptus appears initially like the 'gummosis' disease and produces dark brown patches on the grey bark accompanied by irregular longitudinal cracks which often heal up by the formation of callus tissues from the phellogen unless attacked subsequently by some wound parasites through injuries. In the submontane regions in the north and on the plateau of Central India the Eucalyptus trees planted as park and avenue trees are attacked by the sap and heartrot fungus, *Trametes cubensis*. About a dozen instances of this infection are recorded from different regions during the last 12 years. This fungus, a wound parasite of the other hardwoods of periodically moist tropics, is seen to attack Eucalyptus through lightning scars (Figs. 1 and 2) in Balaghat, Madhya Pradesh and Coorg, and through fire-scars in a plantation in Lovedale, near Ootacamund in the Nilgiris. In Nagpur, Madhya Pradesh and Sambalpur, Orissa (Fig. 3), it is seen to enter through cankers formed by sun-scorch also. In New Forest, Dehra Dun, the fungus was found to enter through broken branches and also through the pruning wounds not properly treated with antiseptics. It appears in New Forest also as a decay of cut stumps of Eucalyptus.

The fungus is moreover a wound parasite of sal and of the common associates of sal in its natural habitat. It is normally a common slash and stump decay of sal. It decays sal timber

* A detailed description of the morphology and biology of *Trametes cubensis* with illustrations is being published in a paper entitled "The Secondary Parasites of Sal" as an Indian Forest Record.

used for out door structural construction such as fence posts, overhead reservoirs for water storage, bridge shafts, jetty poles, telegraph and hydro-electric poles, etc., in the *tarai* towns of Assam, Bengal and Uttar Pradesh.

The fungus produces a brown carbonizing rot in the wood (Fig. 4). The rot in the sap and heartwood is characteristic and the decay can be diagnosed even in the initial stage by the discoloration of the wood to a brownish colour. In the advanced stage the colour deepens to dark brown and hair-like shrinkage cracks appear in the wood later followed by cross-shakes, and in the final stage thin papery mycelia of 'tilleul buff' and 'vinaceous buff' are formed in the radial rays when the wood breaks up into cubes (Fig. 4).

Sporophore—Sporophores tough when fresh, corky to coriaceous, rigid on drying, imbricate, single or in clusters, effused-reflexed to resupinate, semi-circular or irregular in outline, measuring $2\cdot5$–$6\cdot5 \times 1\cdot5$–3 cm. and up to 1 cm. thick ; upper surface faintly zonate to almost azonate, 'pale pink' to 'pinkish buff' changing to 'pinkish cinnamon' and 'cinnamon buff', sometimes with crust 'bister' to 'mummy brown' towards the base of old sporophores ; hymenial surface concolorous, 'pale ochraceous buff', 'pinkish buff' to 'pinkish cinnamon', when dry, dull to velvety, soft to touch ; pores minute round and uniform, 4–6 in one mm. ; pore tubes about 3–4 mm. long, concolorous with hymenial surface when dry ; context concolorous, soft when fresh, 'pinkish buff', 'pinkish cinnamon' showing thin narrow, concentric zones in section ; tramal hyphae colourless, thick-walled, branching, non-septate, $3\cdot5$–$5\cdot4\mu$ broad and thin-walled, hyaline, branching 2 to $3\cdot5\mu$ broad ; binding hyphae hyaline, branching with clamp connections $1\cdot5$ to $3\cdot4\mu$ broad ; generative hyphae hyaline, thick-walled with simple septa and with clamp connections, $3\cdot0$–$4\cdot5\mu$ broad ; basidia hyaline, clavate, 14–16×6–8μ ; spores hyaline, oblong-longish, $4\cdot6$–$6\cdot0 \times 2\cdot0$–$2\cdot5\mu$; sterigmata, thin, $3\cdot6$–$5\cdot0 \times 0\cdot7$–$1\cdot0\mu$ width at the base.

Spores are discharged during the monsoon months, from July to August, and the basidia collapse and cellular layers are formed in the tubes about the middle of September after which the fungus becomes inactive.

Cultural characters—The fungus is slow growing, and revives 24 hours after transfer, producing sparse downy hyphae which partially cover the inoculum in 48 hours and completely after 4 days, after which the mycelia descend on the media. On the slant, however, the fungus appears more active producing woolly growth on the inoculum, and thereafter, velvety mycelia are formed in patches on the inoculum adjoining the initial growth. The character of the mycelia changes to woolly and velvety in patches in about a week but the formation of mat is poor.

Optimum and inhibition temperatures for the growth of the fungus are 28–30°C. and 15–36°C. respectively and rate of growth is :

During first 48 hours	*Nil*	Approximately 4 cms. in 8 days.
,, second 48 hours	not appreciable	
,, third 48 hours	$1\cdot5$ cms.	
,, fourth 48 hours	$2\cdot5$ cms.	

Character of the mycelium—Aerial hyphae hyaline, thin-walled, uniform branched, $2\cdot5$ to $3\cdot5\mu$ broad with clamp connections, appressed hyphae slightly thick-walled, branching, $3\cdot0$ to $4\cdot0\mu$ broad with clamp connections ; submerged hyphae irregular, short-celled, branched with clamp connections and later-fusions, $3\cdot0$ to $5\cdot0\mu$ broad.

There is a good deal of similarity between the sporophore of *Trametes cubensis* and *Fomes roseus*, the latter occurring in the Himalayas, principally on the conifers. The rot produced by *Fomes roseus* is also of brown cuboidal type, the decayed wood varying in colour

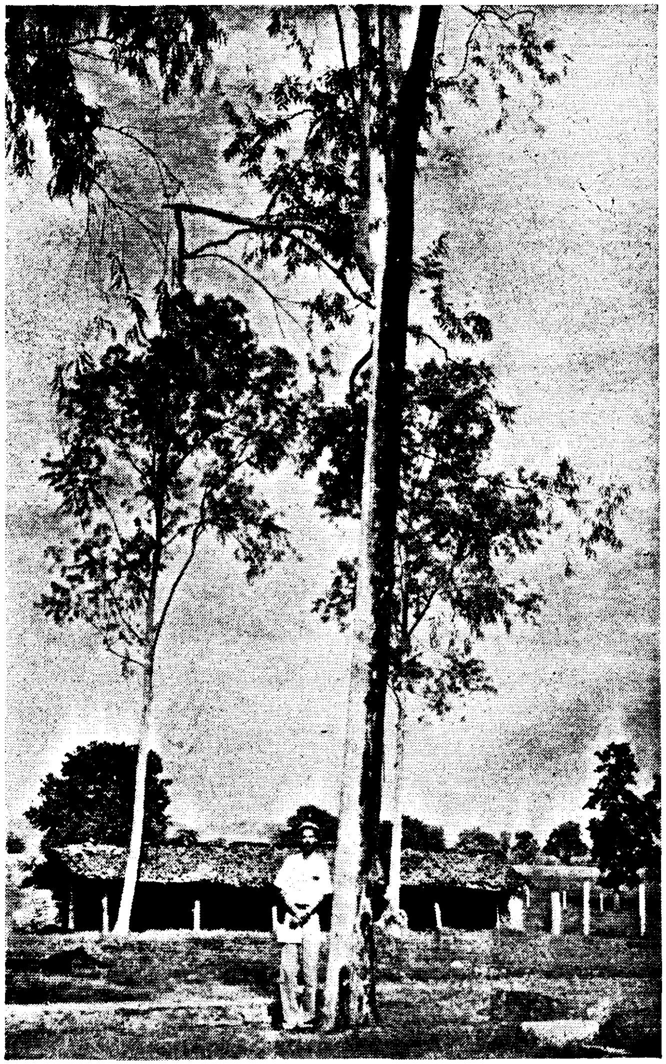


FIG. 1

FIG. 2

FIG. 3

FIG. 4

from light to dark brown and cracks being formed by shrinkage. In the final stages of decay, thin sheets of 'vinaceous buff' coloured mycelium may develop in the cracks like those of *Trametes cubensis*. The cultural characters are however different.

Oxidase reaction—No diffusion zone on gallic acid agar, growth 7 mm., no diffusion zone on tannic acid agar, growth 2 mm. in 8 days; on gentian violet no discolouration, growth moderate.

Loss of weight of wood after 4 months' test at 32°C.

		Sapwood blocks		Heartwood blocks	
		Eucalyptus	Sal	Eucalyptus	Sal
Loss of weight %	Min.	10·50	4·37	8·47	0·51
	Max.	48·16	41·25	30·71	8·99
	Av.	35·42	22·81	20·11	4·80

The colours described in the paper under inverted commas, are based on 'Color Standard and Color Nomenclautre' – Ridgway.

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AFFORESTATION IN THE 'KHOLAS' OF HASTINAPUR (MEERUT)

BY R. L. SRIVASTAVA
Forest Ranger, Uttar Pradesh

SUMMARY

In collaboration with Colonization Department, the Forest Department, U.P. has recently undertaken reforestation of Ganga "Kholas" in Meerut District. Natural cover has so far been inhibited by biotic agencies with the result that the conditions have deteriorated and retrogression set in. Soil wash-off and formation of ravines has been very active. This article provides the general history and the technique involved in the control of erosion by raising large scale plantation.

Introductory—Following the partition of the country in 1947, the Government faced the problem of rehabilitating the migrants. Near the historic town of Hastinapur (Old Capital of Kauravas and Pandavas) in Meerut District, vast areas were lying unused along the river Ganga. It is a part of the U.P. Government scheme (1) to inhabitate large areas of Ganga Khadar (low-lying semi-marshy land in close proximity to the river Ganga, being its old bed) so far lying waste, by refugees, political sufferers and ex-servicemen, (2) to provide them with land for cultivation, (3) to build a future market town of Hastinapur and (4) to afforest the badly eroding 'Kholas'. The 'Kholas' are comparatively high level land characterized in the present state by undulating terrain, badly cut up into numerous ravines and bearing scrub – jungle.

Area dealt with—About 4,000 acres of 'Khola' land stretching in a belt of over 12 miles length, the width varying from 2 furlongs to a mile, has been taken up for afforestation. The remains of the old Hastinapur town fall almost in the middle of this belt. Hastinapur is connected with Meerut by a *pakka* road, the distance being about 24 miles.

Topography—The ravines cut this belt along the breadth. Water descends through them into 'Khadar' and ultimately meets river Ganga. The rugged nature of the 'Kholas' has recently taken its shape due to the removal of thick vegetative cover. Small rainy season rills start in the western limits of this belt, specially from adjoining agricultural fields and the general slope being towards east (towards Ganga) they assume the shape of broad and deep ravines as they reach the eastern limits. Water-table varies from 12 to 45 ft. in depth.

Soils—Great diversity in the nature of soil within the "Kholas' and even within individual compartments makes the classification extremely difficult. It has, however, been realized that the changes in the soil types generally follow the topography, so that a broadline classification is possible with relation to the topographical features ; which follows :—

(1) *Clayey tops*—Uplands left by eroding gullies have got clayey texture. The vegetative growth on such tops is sparse, the small grasses being generally found, e.g., *Aristida adscensionis* (*Safed lappa*) or *Cenchrus ciliaris* (*Anjana*).

(2) *Sandy tops*—Sand hillocks frequently exist towards the eastern side, close to the junction of 'Khola' and 'Khadar'. These are thickly beset with *Sachharum spontaneum* and other grassy growth. Shrubby and tree growth is also common : and, it is this cover alone which can be ascribed to be responsible for the maintenance of such high sand hillocks which could otherwise have easily eroded away.

(3) *Alkaline tops*—Sometimes the clayey tops have saline or alkaline ingredients in the uppermost layer. Generally a *kanker* layer is found just underneath the saline crust. Such tops are almost completely devoid of vegetative growth.

(4) *Clayey depressions*—Big and broad valleys are often deposited with impermeable layer of silt, giving rise to clayey bottoms. Water logging does occur hither and thither locally for a considerable period. *Dub* grass is extremely common here. *Butea frondosa* is the characteristic tree growth. *Vitex negundo* is also found.

(5) *Sandy depression*—Formed by the deposition of transported sand in the ravine beds, these depressions are almost always thickly covered with heavy growth of *Munj* (*S. munja*) clumps. Other grasses are also common.

Climate—On the whole the climate is arid. Hot winds in the summer afternoons and chills in the winter dawns are the characteristic feature. Effect of drought and frost are pronounced, the latter specially in depressions.

Monsoon rains average to 40 inches. Winter rains are scanty.

Nature and Ecological Status of Forest—The general appearance of the tract together with the only existence of unpalatable scrubs at once reveals to a first observer that there existed a thick forest in the past over this area. It is surrounded on all sides by human population who maintain several hundred heads of cattle per village. They solely depended upon these forests for their timber and fuel requirements and for fodder and pasture to their cattle. There is no doubt, therefore, that the casual agencies leading to such a retrogressive stage are purely biotic. Indiscriminate human hacking and subsequent unscrupulous grazing and browsing have led to what we call a scrub forest to-day. Sporadic appearance of species like *sissoo*, *siris* and *semal*, etc., and their young regeneration existing under the thorny bushes of unpalatables (where they could escape grazing) leaves the least doubt that the regeneration of economically better species can be obtained in profusion if the inhibiting biotic factors are eliminated by effecting closure.

If we, therefore, introduce the seeds of economically valuable species suited to the locality and strictly prohibit grazing browsing and hacking, the successful growth of a thicker and more valuable forest is ensured – hence the scheme of large scale plantations.

Existing Vegetation—Rare tree species that are found are :—

Butea frondosa, *Dalbergia sissoo*, *Albizzia odoratissima*, *Acacia arabica*, *Melia azardirachta*, *Bombax malabaricum*, *Erythrina suberosa*, *Flacourtia romantchi*, *Streblus asper*, *Diospyros cordifolia* and *Ficus* sp. *Phoenix sylvestris* is found in profusion in depressions along the eastern edge.

Bushy growth of the following is abundant :—

Diospyros cordifolia, *Carrisa* sp., *Casaeria tomentosa*, *Zizyphus* sp. (extremely profuse), *Adhitoda vasaca*, *Capparis horrida*, *Nyctanthes* sp., etc. In very damp ravines stunted growth of *Mallotus philippinensis* has also been seen. *Helecteres isora* and *Grewia* sp. (*Falsa*) are also abundant.

Grasses and Climbers—

Extremely abundant—*Sachharum munja*, *S. spontaneum*, *Desmostachya bipinnata* (*Dab* grass), *Apluda aristata* (*Bhanjura* grass), *Cynodon dactylon* (*Dub* grass).

Commonly found—*Dichanthium annulatum* (*Bari Jargi*), *Bothriocloa pertusa* (*Chhoti Jargi*), *Cenchrus ciliaris* (*Anjana*), *Cymbopogan contortus* (*Kala Lappa*), *Artistida adscensionis* (*Safed Lappa*).

Scarcely found—*Pollinidium angustifolium* (*Bhabar* grass), *Arundo* sp. (reeds).

Climbers or Climbing shrubs—*Ichnocarpus frutescence*, *Zizyphus* sp., *Capparis horrida*.

Afforestation works—

Objects—(1) To further check the accelerated erosion and gulley formation and thereby to prosper *Khadar* Agriculture.

(2) To raise better fodder grasses for provision of pasture land to the local cattle.

(3) To supply timber and fuel requirements to the future township of Hastinapur and adjoining colonized villages.

(4) To preserve and enhance the aesthetic amenities of the future township.

Scheme—In 1950, a Forest Range was established to execute the Afforestation works. By the end of 1952, all the 4,000 acres have been duly planted up in the following manner :

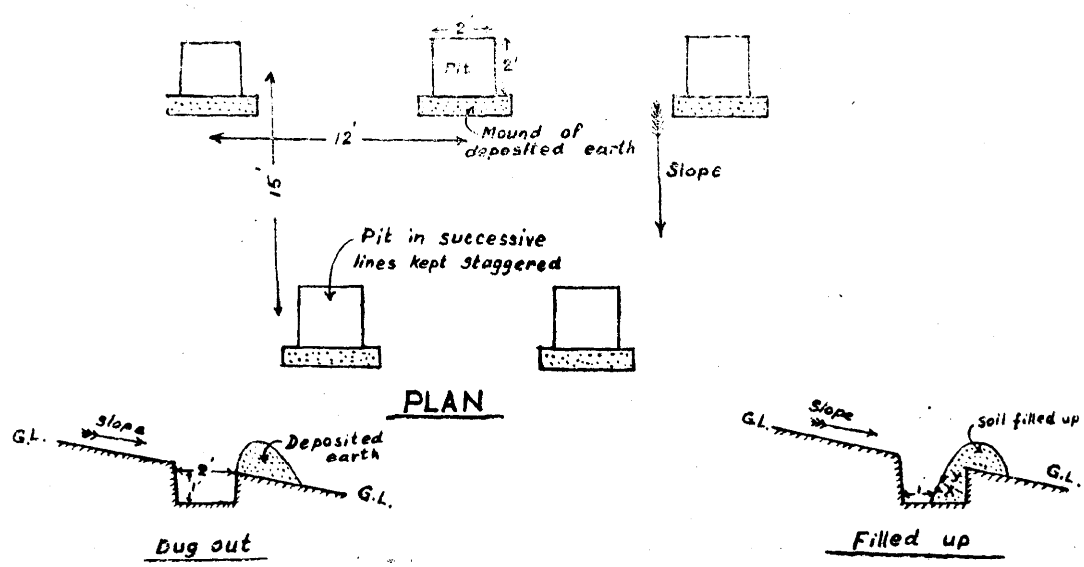
1949–50	..	..	..	500 acres
1950–51	..	..	..	1,200 ,,
1951–52	..	..	..	2,300 ,,
		TOTAL	..	4,000 acres

In addition, six miles of road-side avenue was also planted partly on Mawana–Hastinapur road and partly on different roads in the township.

The scheme was financed by Colonization Department.

Sequence of Operations—(1) *Soil working*—Soil was worked in various ways as suited to the local conditions. Whatever the method adopted, an attempt was always made to conserve the maximum of rain-water to firstly check the run off and thereby stop erosion (erosion control) and secondly to preserve moisture for the successful growth of the seedlings during the periods of desiccation. Based upon the degree of success obtained by a particular method, change-overs to better methods were adopted.

(*a*) *Pit and Mound method*—Localities where tractor ploughing was rendered impossible due to the steep gradient or profuse bushy growth or rugged nature of the country, were worked with this method during 1949–50 plantation.



SECTION

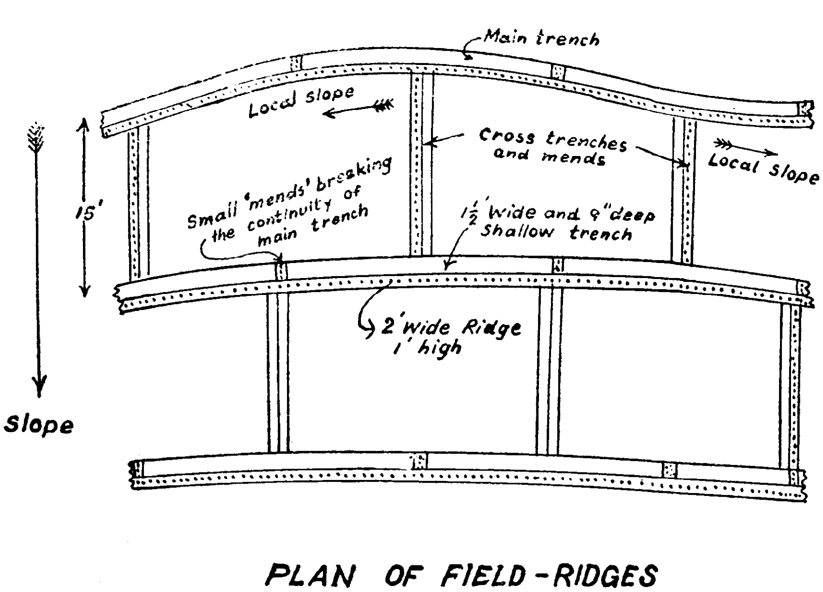
Pits were dug $2 \times 2 \times 1$ feet in lines about 15 feet apart. The distance from pit to pit within the same line was kept 12 feet. An attempt was made to deposit the excavated earth to the lower-side as indicated by the sketch. The excavated earth was allowed weathering throughout the hot season and was filled back again in the pits in June in the manner as shown in the sketch.

At the end of year this contrivance was found to be insufficient to conserve enough quantity of moisture as required for successful growth of seedlings.

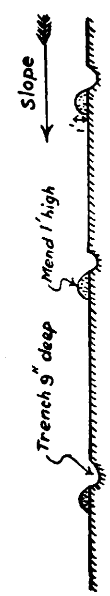
(*b*) *Trench and Ridge method*—Here trenches instead of pits were dug $10 \times 2 \times 1$ feet size, in lines as in the pit and mound method. The distance between trench and trench in the same line was kept 10 feet.

This method compares well with the continuous contour trench method later to be described and differs in that here the distance from trench to trench is 10 feet so that it is not a continuous trench. Again, the lines are not strictly in the contour. This method, however, is an improvement upon the "pit and mound" method.

(*c*) *Field-ridge Method* (*Kisan mend bandi*)—Areas of considerable dimensions, flat or almost flat and with sparse tree growth were initially tractor ploughed. An attempt was made to run the furrows along the contour. The loosened earth thus obtained was piled up along the length of the furrows at intervals of 15 feet in the shape of ridges in such a manner that each of the said ridges had a shallow trench immediately close to its bottom towards the upper side. The continuity of the trench is broken by keeping small 'mends' across at intervals of about 15 feet. This would facilitate the control of run-off due to any local slope which could otherwise turn the trench into small *nullah*. In flat areas some similar trenches have been made across the main trenches so that there is a net work of such trenches. The following will illustrate the details.



PLAN OF FIELD-RIDGES

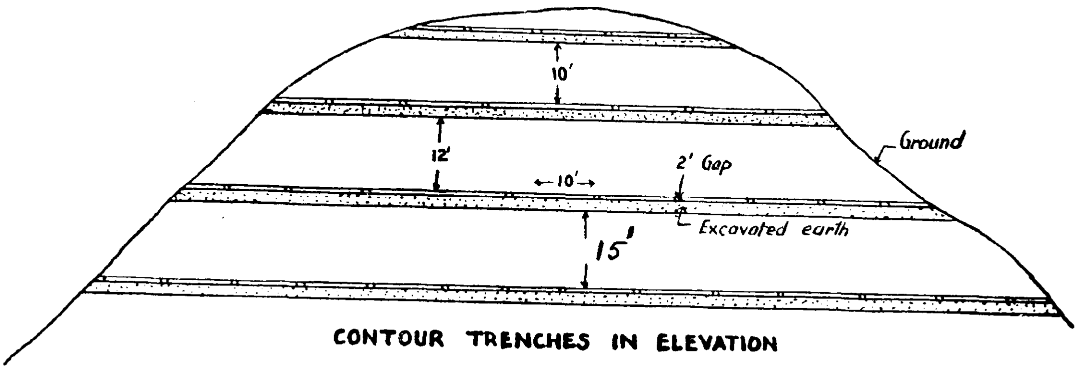


FIELD-RIDGES IN SECTION

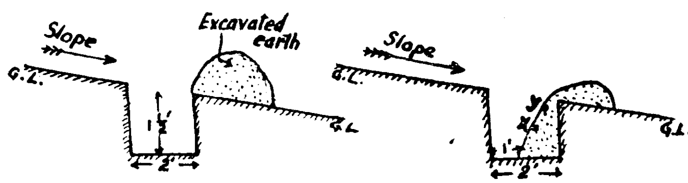
This method has given extremely satisfactory results. It is, however, limited to areas workable by tractor.

(*d*) *Contour trenching*—Areas where tractor ploughing was not practicable, a method alternative to (*a*) and modification of (*b*) was tried. Trenches $10 \times 2 \times 1\frac{1}{2}$ feet were dug

along the contour as accurately as possible with ocular judgement and the dug-out earth is essentially deposited on the lower side. Such contour lines run 10 to 15 feet apart depending upon the degree of slope. The distance from trench to trench is kept 2 feet, but the ridge formed of deposited earth is kept continuous. Trenches in the successive lines are kept staggard. Special attention is paid in plugging the *nullahs* at their very head by this method. The plan and section of these trenches is given below for clarification of the point.



CONTOUR TRENCHES IN ELEVATION



C. Trenches in Section (Excavated)

C. Trenches in Section (filled up)

This method has got two-fold advantages :—

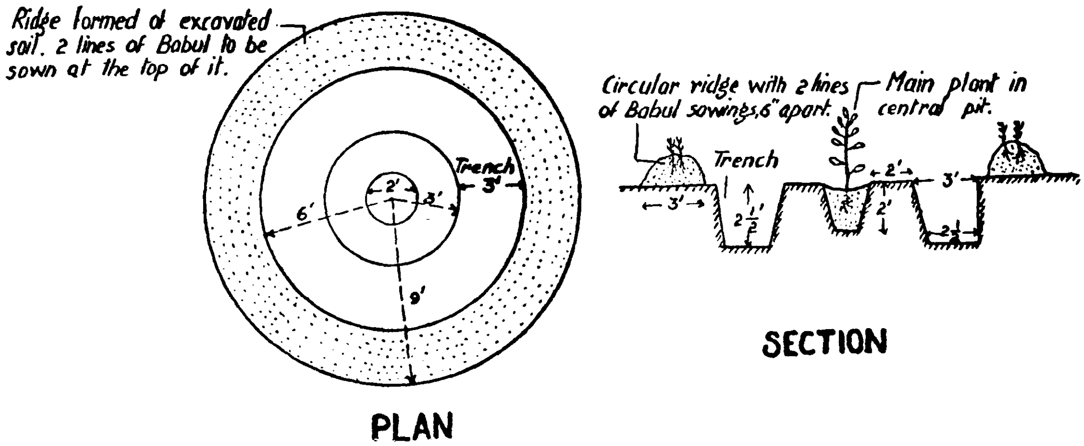
(1) Better control of erosion.

(2) Better conservation of moisture, hence more successful growth.

(*e*) *Circular trench method*—Soil working for the plantation of avenue trees was done in a special manner. Round the circular central pit (2 feet dia. × 2 feet) a circular trench is dug of the size and shape as given in the sketch. The earth excavated is deposited round the perifery in the shape of a circular ridge on which *Babul* is sown just before the commencement of monsoon. The distance between pit and pit is kept 40 feet for species like mango, *jaman*, *imli*, *bahara* and *arjun*, etc. It may vary with the requirements of particular species planted. The distance of pits from the centre of the road is usually kept 35 feet.

Such trenches are cattle proof. In addition to this, the presence of a thorny hedge of *babul* hardly ever allows cattle to damage the main plant standing in the centre.

This method has been found quite successful and can be largely adopted in avenue plantations specially where incidence of grazing is intense, more so on account of its cheapness as compared to many other methods of safeguarding the avenue plants. In townships or habitations, however, this should not be recommended.



(2) *Filling*—After the soil working the earth excavated is allowed to weather up to June, when it is filled back partially in the trench in such a way as to make an angle of repose suitable for sowing. The method has been illustrated in each case in the preceeding sketches.

(3) *Sowings*—An attempt is made to finish the sowings before commencement of the monsoon. Small furrows are made along the length of ridges (horizontally) at points marked 'X' and 'Y' thus giving two lines sown. The position of 'X' and 'Y' migrates up and down slightly with the nature of soil. If the soil is pure sand 'X' goes at the bottom and 'Y' nine inches vertically above it and vice versa. Sometimes in locations where there is danger of more water collecting in the trench, a third line of sowing is adopted running 6 inches above ground level. Some broadcast sowings in previously tractor ploughed areas were also undertaken experimentally.

(4) *Planting*—In early July planting of stumps of suitable species begins on a large scale. In fact roots and shoot cuttings have been found extremely successful in localities infested with grassy weeds and facing desiccation. Cuttings are a definite advantage in making the plantations a success, specially where sowings fails. One cutting on one ridge often serves the purpose. Planting of entire transplants is also done specially as shade line on the road sides.

(5) *Weeding*—Soon after germination first weeding starts because of the heavy growth of grasses. Ordinarily two weedings are a necessity, but areas adjoining *Khadar* demand not less than three. A fourth weeding is beneficial if done soon after rains. Spacing between plants is also effected. A space of 2 to 3 inches is provided at first weeding, 4 to 6 inches at the second and 9 to 12 inches at the third.

(6) *Munj eradication*—Excessive growth of *munj* suffocating the sowings is dug-out in strips 8 feet wide to free the lines of sowing.

Choice of Species—Before actual sowing starts, a general soil-cum-topographical survey of the tract in question is undertaken to determine as to which area is suited for which species. The choice is based upon the following considerations :—

(*a*) *Climate*—Whether depression where frost will accumulate or otherwise.

(*b*) *Soil type*—Clayey, sandy or alkaline.

Direct sowing with a mixture of usually two and occasionally three species is done and to allow the resulting seedlings avail of the maximum period of growth, it is finished just

earlier than the first shower. The following table gives a general idea regarding the selection of suitable species.

Type of soil	Characteristics	Species proposed
Clayey stop	Generally stiff soil, bad aeration, no frost.	*Bahera*, *Babul*, *Nim*, *Sissoo*, *Mahwa*, *Amaltas*, etc.
Sandy tops	Loose, less retentivity of moisture better aeration, no frost, drought pronounced.	*Sissoo*, *Kala siris*, *Kachnar*, *Kanji*, *Kanju*, *Anogeissus pendula*, *Aonla*, *Ailanthus excelsa*, *Bignonia* sp., etc.
Hard alkaline tops	Very hard, dry in summer, physiological drought.	*Babul*, *Prosopis juliflora*, *Nim* and *Acacia leucophloea*, etc.
Sandy depression	Drought in summer, frost in winter, suffocation by heavy growth of *munj*.	*Sissoo*, *Khair*, *Semal*, Mulberry (Root and Shoot cuttings always better).
Clayey depression	Stiff and water-logged in rains, frosty in winter.	*Sissoo*, Mulberry, *Jaman*, *Asna*, *Arjun*, *Tun*, *Kachnar*, etc.

A NIGHT WITH INSECTS AND A JEWELLED SNAKE

BY SURENDRA PRATAP SAHI, U.P.F.S.
Divisional Forest Officer, Banaras

There was a swarm of insects round the yellow light of hurricane lantern. The insects flapped against the hot glass chimney and scurried over the heated metal top. Many had their limbs and mandibles singed ; yet, they wriggled round and round. Many lay still and topsyturvy, cold and dead. They were the fallen heroes of a dumb community. There were small heaps of silken wings on the ground which glistened in the light. Yet the onslaught continued unabated. There were moths carrying tawdry patterns on their wings, tail-coat beetles with metallic sheen, winged ants, locusts, praying mantis and a host others.

The flutter of innumerable wings caused a faint buz. To the nocturnal stillness of the the sylvan setting, this weird music lent a quaint rhythm. Nothing beyond the rays of the light was perceptible. A bloated darkness reigned supreme. Even the sky was impalpable without the moon and the stars. The dew-kissed blades of grass waved wistfully in the light with the bustling insects or the breeze that swept over them.

A bleak wind blew past midnight. Suddenly the lantern in the open outside my tent flickered and the next moment there was utter darkness. Perhaps some insect had landed on top of the burning wick and flared up heavily with it.

I shuffled in my sleepers and came out. I shook the dead lantern and relit it. My hands were slightly oiled with kerosene and dust that kept floating in the night air.

The insects again assailed the light. One beautiful moth dived straight down. I trapped it gently. A couple of sleek skinks soon appeared and began to swallow the smaller insects.

I returned to bed and slept soundly for an hour or so. The sound of a "Click" awoke me. Something had perhaps, dropped down from the table. The streak of yellow light from outside still showed the leg of my camp table. Then suddenly I noticed another light on the middle of the floor by the table. The light sparkled. It moved. Slowly it sauntered in a hectic manner, stopping abruptly and then moving again, until it scuttled out of my tent.

I was neither frightened nor dazed. I had heard of jewelled snakes though with sceptic belief about their story.

Seized by a grotesque curiosity, I lifted the rear flap of my tent and peered excitedly. There was the most fascinating object gliding incredulously under my very vision. The jewelled snake was heading towards the bush. Its gait was graceful and unfrightened. It paused and moved ; paused and moved. The tender grasses shuffled beneath it, at times rather harshly. In the radiance of its jewel its body was camouflaged in the darkness and I could not see it.

I had to think and act quickly. In a second I brandished my shot gun and fired. It hit the middle of the reptile and rendered it immobile, perhaps dismembered it into shreds, its precious stone still glittering rigidly.

When I searched the spot the snake had disappeared. Only the jewel was twinkling amid grasses. Some fresh blood stains were visible on the grass. With an iron forceps I hauled up the jewel. It came up rather clumsily with a dark cylindrical appendage. I looked on agape and identified the jewel as my own miniature torch light-cum-fountain pen which I had kept on the table. Nearby lay a dead rat bespattered with warm blood !

SHOM-PENS OF THE GREAT NICOBAR

BY B. S. CHENGAPPA

For long it was believed that the interior of the Great Nicobar was inhabited by a race of Negritos similar to the wild tribes of the Andaman Islands. Their existence was reported by Pastor Rosen, a Danish Missionary in 1831. In 1846, Admiral Steen Bille paid the first recorded visit to this Island. This was followed by three visits by Mr. De Roepstorff and on one of these occasions in 1881, he was accompanied by the Chief Commissioner, Colonel Cadell. Mr. Man, first visited them in 1884, and maintained occasional contacts for sometime. In 1901, Boden Kloss and in 1905, C. W. B. Anderson also visited them.

It was then found that these Shom-Pens belong to the same stock as the other inhabitants of these Islands – an isolated group of the primitive Malayans – and that, later some unknown causes brought about a division among them into two distinct ethnological groups – the Shom-Pens of the interior of the Great Nicobar, and the coastal people, or the Nicobarese. The Shom-Pens appear to have a remote admixture of Negrito blood, they are a shade darker and are also slightly smaller in stature than the coastal people. Their hair occurs in all the grades between curly and straight and their appearance also varies greatly from the Nicobarese.

To account for this difference in hair and for the dull-brown colour of the skin, two theories are advanced : the first is that possibly the Andamanese, on one of their predatory excursions to these Islands, for some reason, were unable to return and were incorporated with the local inhabitants. The people of Car Nicobar still believe that the Andamanese in the long past, came down in several canoes for their periodical raids. The second and a more probable theory is, that these peculiarities are due to a Dravidian strain, and that some Dravidian mariners, in their trading voyages to the Eastern Archipelago, became stranded in these Islands and later got incorporated with the local people.

The Shom-Pens are divided into two divisions. The smaller have been living nearer the coast and few miles up the big rivers – Jubilee, Dogmar, Alexandra and Galathea. These have been friendly with the Nicobarese, and only these friendly tribes have been visited in the past explorations. These are referred to as "Mawas Shom-Pen" meaning quiet or tame Shom-Pen. The larger section who inhabit the interior have always been hostile and have continued their nefarious work of raiding and killing the Nicobarese and the friendly Shom-Pens. One of the Nicobarese guides in the present expedition, Berengse, who belonged to the East Coast, told the party that when he was about 10 years old, – he is about 60 now, – a pitched battle was fought between the hostile Shom-Pens and the Nicobarese and others, led by a British Officer near Campbell Bay. In this battle, many on both sides were killed including his own brother. However, eventually the wild Shom-Pens managed to wipe out all villages on the East Coast. Berengse and his people shifted to Kondul, and others to the West Coast.

It is said that in the exploration of the Andaman Islands in 1857 under Dr. F. J. Mouat for establishing a Colony, one of the nervous and imaginative members brought news of a lurking body of aborigines. The Doctor addressed his followers in a warlike speech and gave orders to charge. They charged immediately and discovered that they had knocked down some burnt tree stumps which they had mistaken for the wild tribes. Subsequently they had several serious clashes and quite a few of the aborigines were killed. This apparently led to the deep rooted hostility that still prevails amongst the Jarawas of the Andamans. Protection against these hostile tribes is now costing the Government more than Rs. 40,000

per year. The present expedition to the Nicobar Islands was determined to see that such mistakes are not repeated and that there would be no retaliation even if the party was attacked in their attempt to penetrate the interior.

The exploration party first came into contact with the Shom-Pens in the Jubilee river. They were friendly and were already known to the guide. The Head-man Akanya of the Shom-Pens, took the party right up to the very source of Jubilee river, stayed a night with the party in jungle and brought them back to Ganges Harbour on the north of Great Nicobar. Next, they came in contact with the Shom-Pens living about 5 miles from the mouth of the Dogmar river. They were also friendly and well known to the guides. Two of them Lonava and a boy about 16 years, accompanied the party in their own two-men canoe, stayed two nights with the party in jungle, took them about 15 to 25 miles up this river, and followed them to their camping place at Pulo-Kunyi.

The third lot of the Shom-Pens were found many miles in the interior of the Alexandra river valley, 12 or 14 miles up the main stream from its mouth and then about 2 miles up a branch stream on the south. These were wild and hostile. Fortunately, Lonava, the friendly Shom-Pen from Dogmar had accompanied the party. The first sign of the presence of wild tribes in these parts was, their foot prints on the bank of Alexandra river. At the sight of fresh foot prints of human beings, one of the party shouted and there was a prompt reply. This was repeated three or four times before the party saw a young man about 25 years old, walking boldly towards the canoe that was being paddled up stream ; a young woman with three children rushing off into the jungle for safety. They were naked except for a bark cloth covering their shame. The young man had about a dozen javelins ready poised to throw at the people in the canoe. The friendly Shom-Pen shouted at the top of his voice in his language that the party means no harm. Thereupon, the wild man threw down his javelins and walked forward a few paces, threw down his *dah* and came straight to the canoe. He was immediately given sweets, *beedies,* tobacco, etc. He did not know how to smoke a *beedi* until he was taught to smoke. He guided the party to their huts about 2 miles away along a branch stream. These sheds were so remote that they could never have been discovered but for the guidance of the wild Shom-Pen himself. At the camp only two men were found, all the women and children having run away to hide themselves. After the men made certain that the party meant no harm, they brought their women and children and allowed themselves to be photographed. The expedition party was completely unarmed. On being requested, three of them including their head-man came with the party in their canoe to the camp, received cloth, *dahs,* sugar, etc., as presents and parted as good friends. They, however, refused to go the coast with the party.

The fourth lot of the Shom-Pens were found many miles in the interior of Galathea river. The friendly Shom-Pen, Lonava, refused to accompany the party any further and returned to his hut near the mouth of Dogmar river, as he thought that the rest of the Shom-Pens were all very wild and very hostile. The Nicobar guides, however, followed the party and came in contact with another lot of Shom-Pens about a mile away from the bank of the Galathea river and about 14 or 15 miles from its mouth. While approaching the Shom-Pen huts, only the Nicobar guides, two of the expedition party, showed themselves first ; the others were hidden close by, behind trees watching developments. The two who went forward had taken off their clothes and were almost naked but for a loin cloth. At this sight, two Shom-Pens, a boy of 18 or 20 and another 10 or 12 years, rushed out with all the javelins and were about to strike. The guides had instructions not to fight or to show any signs of fear but hold up their hands and show that they are unarmed. They acted their part very well and the Shom-Pens were a little confused and after a little hesitation threw down their javelins and came forward. The others of the party who were hiding also came out at the same time. After

exchange of few words and presents, the women and children were sent for. While waiting for women and children to return, the head-man who apparently had gone out hunting, also returned armed with about 10 or 12 javelins and started talking to the party as though he had known them for years. After they were photographed and more presents were given, the party returned to the canoe followed by the head-man who was promised clothes, *dahs*, and an axe, at the camp. These Shom-Pens had no axe, and the *dah* they had was a very poor specimen, very old and worn-out. The head-man, though he got into the canoe without much persuasion, became very nervous and at every bend of the river on the downward journey wished to get ashore and walk home. He was, however, persuaded to stay on. The party had not gone a mile down stream when the two boys, with all the javelins they could collect, appeared on the bank, all agitated and angry, and threatened to kill everyone of the party if their man was not set ashore at once and on the spot. He had worked himself to such a pitch that his naked body showed that he was trembling in every limb from head to foot and he was ready to execute his threat if it is not obeyed.

The party immediately allowed the head-man to land and requested him to follow the canoe and then to the camp. He agreed and followed the canoe for about half a mile and shouted back whenever the party shouted from the boat. At this stage, one of the Nicobar guides got ashore hoping to lead the Shom-Pens to camp. On the shore he shouted to them and there was no answer or any sign of them and he arrived at the camp alone. After two or three hours, the guides were sent again to the Shom-Pen huts with clothes, *dah* and other presents, and with instructions to leave all the presents in their huts if they are not there. When they arrived they found the huts deserted, they however, left all the presents in their huts.

The Nicobar guides were extremely nervous in Galathea river, and when it was suggested that the expedition will next shift to Campbell Bay and Trinkat-Chamlong Bay on the east, they were vehement that the Shom-Pens will attack the party. However, these objections were over-ruled and the first camp on the East Coast was made at Campbell Bay. At this place, the party saw some recently abandoned Shom-Pen huts, evidently abandoned while the party was exploring this Bay a week previously for making a camp for assessing the forests. In Trinkat-Chamlong, however, two Shom-Pens came to the expedition camp on their own and took the members of the party to their huts, perched on a hill-top and a few miles inland. They were anxious to obtain axes, *dahs* and clothes. They were successfully persuaded to visit *M.L. Valdora* that was anchored in the Bay. They returned quite happy with all they wanted.

Estimate of their number—With the exception of a few families who have friendly intercourse with the Nicobarese, these Shom-Pens have persistently been hostile to the coastal people and to any one who dared enter their territory. Therefore, their number has always been a guess work. Boden Kloss estimated their number in 1905 at 300–400 and subsequently a large number was wiped out by influenza and later by other diseases. In the Dogmar river valley, there are now only 14 persons in all, sickly and dying, and the Shom-Pens in Alexandra river have disappeared completely because of these diseases. The few survivors, one of them, Lonava, migrated to Dogmar. Those found in Alexandra, came from the interior and have never been friendly with the Nicobarese. Likewise, those now found in Galathea have also never been friendly in the past, the friendly ones living mostly near the mouth of these big rivers and mentioned by Boden Kloss, have either been decimated by disease, or have been wiped out by the hostile Shom-Pens after they were weakened by disease. The present Expedition, in its extensive exploration, both along the coast and the interior, counted only 48 Shom-Pens – 14 men, 21 women and 13 children. Even if it is reckoned that there is an equal number that escaped contact by the party, the maximum

number of Shom-Pens now in Great Nicobar, cannot be more than 100. It is noteworthy that out of 13 children only two belong to the friendly group.

Their appearance—The Shom-Pens of Dogmar river, both men and women are sickly and will probably die out completely in a few years. Those found elsewhere, especially the menfolk, are fine specimens of human beings, every one with the appearance of an athlete. They are not so strong or so robust as the Nicobarese but they are tough and wiry. Their women, however, appeared weak and in most cases sickly. They are also darker than the coastal Nicobarese. They have a luxuriant growth of hair on their head but none on their face or body. The hair varies from straight to curly but is not frizzy. The general appearance of the Shom-Pens is distinctly Malayan.

Their houses—These wild tribes have no settled homes but wander about from place to place living in crude huts. These huts are built on piles varying in height from 3 ft. to about 7 or 8 ft. with a rough platform and a rough roof of palm leaf. In all the explorations, only one hut of a permanent nature, of the same bee-hive form which is a common feature of the dwellings of the coastal Nicobarese raised about 6 ft. from the ground, was seen near Trinkat-Champlong Bay on the East Coast. Even this had been abandoned. Huts on tree tops mentioned by Boden Kloss were not seen at all. Probably they have discarded this type of huts.

Their food and water—Their mode of life differs but slightly from the Nicobarese. The staple food of both the Nicobarese and the Shom-Pens is Pandanus. They cook them in a well made boat shaped vessel of sheets of bark of *Trema amboinensis* or of *Terminalia manii* or of *Anthocephalus cadamba* or bark of similar species. The cooking pot is about 5 ft. long, 2 to 2½ ft. high and about 2 ft. wide. The strips of bark are about 9 to 12 inches wide. One strip is folded lengthwise with the rough surfaces outwards to form a large trough and the bottom of the pot. The folded ends are inserted between two sticks tied tightly together and driven to the ground. Sides are then built up with other strips, the ends being inserted between the sticks. The whole is tightly bound up with strips of cane passing round from stake to stake and along the overlapping edges as well. The stakes at the centre are driven about 2 ft. apart to cause a bugle and give it a boat shape. A number of short round canes are inserted at the bottom and this helps easy lifting of the contents when cooked. They make fire by striking dry sticks. But this need never arises as they keep their home fire always burning.

They hunt pigs, catch fish, and collect fresh water mussels, to supplement Pandanus. Fish, however, is not plenty in these rivers and pigs are rare.

They are very fond of chewing betel nuts and betel leaves. They obtain lime for this purpose by burning shells of mussels found in fresh water.

They are very particular of water-supply and never drink water from any of the big streams or their big branch streams. They drink only the crystal clear water coming in little streamlets straight from the wooded hills and in little cataracts. They usually carry their water-supply in jars and jugs collected from the shores or in bamboo tubes or in troughs made of the spathes of the *Areca* palm.

They are fond of bathing and rarely miss a chance of a dip and a wash when they are near these rivers.

Domestic animals—Of the domestic animals, only dogs have got into their encampment. In Dogmar, their mouth had been muzzled to prevent them from barking loud. The Alexandra Shom-Pens had no dogs but they all had one or two small wild pigs in cages below their huts. The friendly Shom-Pens have dogs, cats, domestic pigs and chickens.

Industries—They make small canoes with outrigger to take two or three persons and these are used only in rivers. They make baskets of rattan and of palm spathe and cloth from the inner bark of two species of *Ficus*, one gives whitish cloth and the other reddish. They make their javelins or darts with iron heads. This is used for warfare or for hunting pigs. They are never seen outside their huts without 10 or 12 javelins, at least three or four of them with iron heads. They throw these about 50 yards and are deadly accurate. While walking in jungle they frequently throw these javelins at a target trying to show their skill in this art.

The friendly Shom-Pens have long been used to clothes. They obtain garments, beads, knives, axes, tobacco, etc., by barter. They are very good at splitting canes. They tie up these canes into bundles and together with bundles of betel nut and limes wrapped up in palm leaves, hang them up on small trees at the mouth of the rivers. The Nicobarese collect them periodically and similarly leave whatever they consider is a reasonable price. They occasionally meet also.

Gardens—They are fond of gardening and have been practicing it since generations. All along the banks of the big rivers, are still found occasional groups of coconut trees 60 or 70 years old, groups of betel nut palm, and an occasional lime tree all now abandoned and neglected. There are a large number of new gardens, half an acre to an acre in extent, planted with very good variety of bananas, tapioca, colocasia, tobacco, yams and Pandanus. The biggest garden, about 3 acres, on a hill-slope of Mount Chaturvedi was found near Trinkat-Champlong Bay. In this area, all trees big and small had been felled and their branches cut and removed. There was no burning. Colocasia, bananas, yams and tobacco were the plants raised. They do all their digging and planting with strong sticks with pointed ends. Pandanus is raised by cuttings and these produce big fruits even when the plant is only 3 to 4 ft. high when all the natural trees produce fruits at a height of 30–40 ft. Apart from these gardens, at every encampment they plant bananas, and colocasia, near their huts.

Their dress and ornaments—Both men and women go about naked except for a loin cloth made of bark worn by women, and a strip of cloth worn by men, in the same manner as the Nicobarese do with a tail behind. The bark cloth of a woman is about 6 to 8 feet long and about 2½ ft. wide. In the olden days, Boden Kloss found them wearing ear-rings made of bamboo (*Dinochloa andamanica*) with pointed ends. In this Exploration, only Akanyo, the Jubilee river Shom-Pen was seen with these rings. Evidently it is out of fashion with them now. The friendly Shom-Pens wear ordinary clothes obtained from the Nicobarese by barter and whether wild or not they all wear their clothes with a tail behind in the Nicobarese fashion. The wild Shom-Pens wear necklace made of broken coral pieced together.

Customs, manners and language—A Shom-Pan encampment usually has 10 to 15 persons including women and children. The oldest man is usually the head-man, but it is not known what control he has over others.

The Shom-Pens whether wild or friendly were seen with only a wife each. The wife and husband with their children live separately in a little shed of their own. Any relative, even an ailing mother or father, lives in a separate shed closeby. The maximum number of sheds seen in any one place was six in Dogmar. Men of 50 or 60 years of age were not found anywhere on this Expedition. Old and ailing women, about 50–60 years old, were found in the Jubilee and Dogmar rivers and also in Trinkat-Champling Bay, all living in separate little huts.

Boden Kloss and other observers have said that these Shom-Pens are very timid. It is unfair to call them timid. In the Alexandra river, the lone Shom-Pen hearing the

party shout, shouted in return, sent away his wife and children, waited until he could see who was shouting, and with all his javelins walked straight to the party, ready poised to strike. Similarly in Galathea valley, only two boys, one about 18 years and the other 10 or 11 years old, boldly came out with all javelins they could collect to face two strong and hefty Nicobarese who showed themselves and three more of the party hiding just close behind. They did not flinch even for a second when all the five appeared on the scene. They are, therefore, by no means cowardly or timid. On the other hand the Nicobarese, though strong, robust and hefty, are terribly frightened of the wild Shom-Pens.

They appear to be very hospitable. They offer *pan* (betel-leaf, betel nut and lime) liberally. While out in the jungle, they collect edible roots and shoots and offer them to their guests. In the Alexandra river, they allowed a very big bunch of ripe bananas, the only bunch they had, to be taken by the Nicobarese guides. In the Dogmar river valley a green bunch of bananas was offered to the Expedition party which they accepted. They freely gave a number of their iron headed javelins and also their bark cloth to the members of the Expedition party.

The language of the Shom-Pens differs from that of the Nicobarese and the language of the wild Shom-Pens differs from that of the friendly tribes. But they appear to understand each other. Their pronounciation and accents are so much alike that non-Nicobarese, see no difference.

Health and condition—The friendly Shom-Pens are weak and emaciated and everyone was found suffering from caugh and cold or some lung ailment. Some women were seen with elephantiasis and Poliomyelitis in the Dogmar river valley. It is only a question of few years before these people will disappear. On the other hand, the wild Shom-Pens are all strong, tough, and wiry, and also very healthy. One woman in Galathea appeared to have suffered from Poliomyelitis; she was limping. The Galathea Shom-Pens were very particular that no one in the Expedition party with cold or other ailment should remain in their encampment. It was gathered that influenza and Poliomyelitis killed a large number of them and some are still suffering from the after effects of Poliomyelitis.

Conclusion—From the numerous gardens now found abandoned all along the big rivers and from the fact that they have been able to wipe out all Nicobarese on the East Coast, it is evident that their number must once have been large. Influenza in 1918, and Poliomyelitis in 1947 have so reduced their number that they have not been able to attack the Coastal Nicobarese for many years now. It is unlikely that they will attack any more, especially after this friendly contact made by the Expedition party with the Shom-Pens living many miles in the interior of these impenetrable forests. The last act of these hostile and much dreaded Shom-Pens near Trinkat-Champlong Bay, coming on their own and taking the party to their encampment and their garden, suggests, that word from mouth to mouth must have gone forth to all the Shom-Pens in the wilds, that the Expedition party is friendly and helpful and means no harm. It is, therefore, hoped that these Shom-Pens will no more be hostile. They are, however, just on the border line of friendship and hostility and their future behaviour depends on the next Expedition. One false step will drive them back again to hostility, just as the *Jarawas* in the Andaman Islands, once friendly have now been driven to be our implacable and ruthless enemies. There should be an Anthropological Expedition as early as possible and for a longer period before the effects of this friendly visit wear off.

TREK TO BADRINATH

BY R. SAHAI, I.F.S.
Conservator of Forests, Uttar Pradesh

1. *General*—Among all the most sacred places mentioned in the ancient books of the Hindus, four stand out on account of their extra-ordinary religious significance. These holy places – now the most important places of pilgrimage in India – are known as *Dhams*. Three of them are situated on the sea coast and the fourth in the Himalayas. These *Dhams* are :—

1. Jagannath, Puri, on the east coast.
2. Rameshwaram, an island in the extreme south.
3. Dwarka, on the west coast.
4. Badrinath in the north, situated amongst the Himalayas, at a height of 10,000 ft. above sea-level.

2. This pamphlet deals with the trek to Badrinath, which can be done easily in 16 days.

3. Badrinath is mentioned in the religious books of the Hindus as the supreme place of pilgrimage. As such, it has been attracting ascetics, sages and religious people from the most ancient times. Even now nearly 25,000 to 50,000 people, from all over India, visit it annually. It is the one place which every Hindu fondly hopes to visit in his life time.

4. *The Route*—Badrinath is about 176 miles from Rishikesh Railway Station (Northern Railway), the terminus of the branch line from Hardwar, a station on the Lhaksar–Dehra Dun branch of the Northern Railway. From Rishikesh the motor journey starts. One has to go by bus from Rishikesh to Kirtinagar, a distance of 63 miles, there cross a narrow suspension bridge over the Alaknanda on foot, again catch a bus at the other end of the bridge for Chamoli, 65 miles away. Badrinath is about 48 miles from Chamoli, along a fairly well aligned bridle-path.

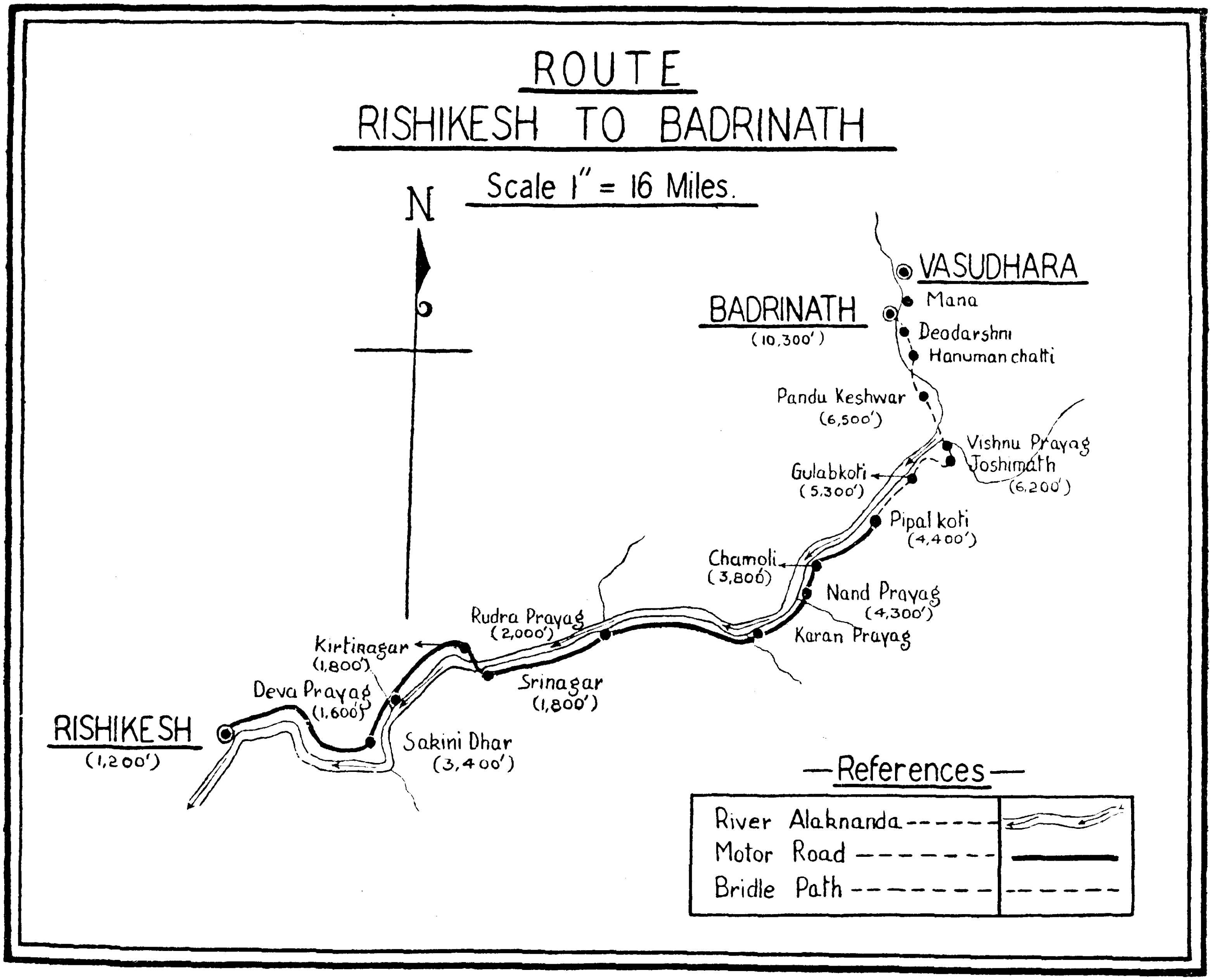
5. *Travellers' bungalows*—Every two or three miles along the route there are places locally known as *Chattis*, or *Dharamshalas*, where pilgrims can stay for the night.

6. For the convenience of pilgrims an institution called Shri 108 Baba Kali Kamli Walla Kshetra, Rishikesh, maintains a large number of these *Dharamshalas* which provide facilities for the pilgrims. Blankets, cooking utensils and medicines are also provided. Grocery shops containing provisions like *ghee* flour, rice, *dal*, potatoes, salt, etc., and tea shops are also found at these places. No fresh vegetables and fruits are generally available. Tinned provisions can be purchased in Rishikesh or Hardwar.

7. The following are the main halting stations along the route from Chamoli :—

Serial No.	Name		Distance in miles from previous halt	Height in feet above sea-level	REMARKS
1	Chamoli	..	0	3,800	P.T.H.
2	Pipalkoti	..	$10\frac{1}{2}$	4,400	P.T.H.
3	Gulabkoti	..	10	5,300	..
4	Joshimath	..	$8\frac{1}{2}$	6,200	P.T.H. Pol.
5	Pandukeshwar	..	$8\frac{1}{2}$	6,500	P.
6	Badrinath	..	$10\frac{1}{2}$	10,300	P.T.H. & telephone.

Note.—P. denotes Post Office. T. denotes Telegraph Office. H. denotes Hospital. Pol. denotes Police Station.


ROUTE
RISHIKESH TO BADRINATH
Scale 1" = 16 Miles.
N
VASUDHARA
Mana
BADRINATH
(10,300')
Deodarshni
Hanuman chatti
Pandu Keshwar
(6,500')
Vishnu Prayag
Joshimath
(6,200')
Gulabkoti
(5,300')
Pipal koti
(4,400')
Chamoli
(3,800)
Nand Prayag
(4,300')
Karan Prayag
Rudra Prayag
(2,000')
Kirtinagar
(1,800')
Srinagar
(1,800')
Deva Prayag
(1,600')
RISHIKESH
(1,200')
Sakini Dhar
(3,400')
—References—
River Alaknanda
Motor Road
Bridle Path

Suspension bridge at Deoprayag.

The confluence of rivers at Deoprayag.
Bhagirathi (*left*) Alaknanda (*right*).

Steps to the temple of
Shri Raghunath Ji at Deoprayag.

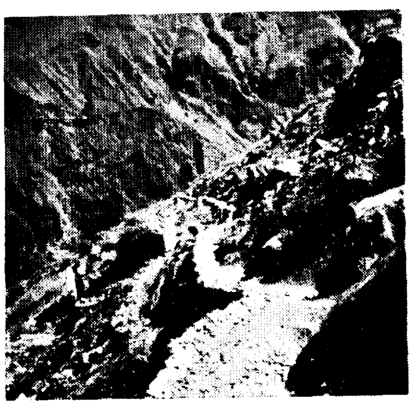
Steps to the *ghat* at Deoprayag.

Cave in rock at Deoprayag.

Rudraprayag with the bridle-path along
the Mandakini to Kedarnath.

Steep hills with small patches of forest.

Cultivation in the Valley.



Land slips and erosion.

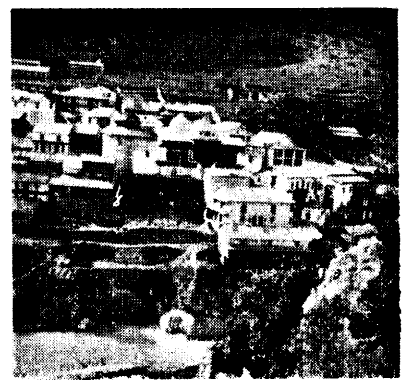
Gorge near Vishnuprayag.

Rocky way between Vishnuprayag and Pandukeshwar.

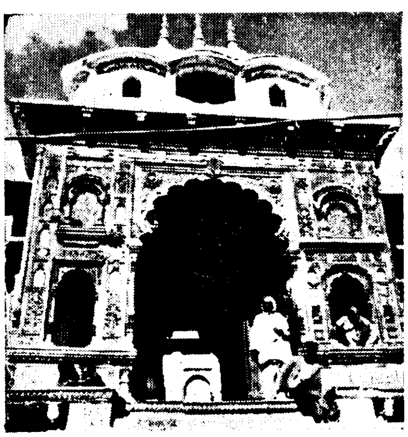
Forests near Hanuman *chatti*.

First view of Badrinath from Deodarshni.

Gentle road from Deodarshni to Badrinath.



Temple buildings of **Shri Badrinath** and *Taptkund.*

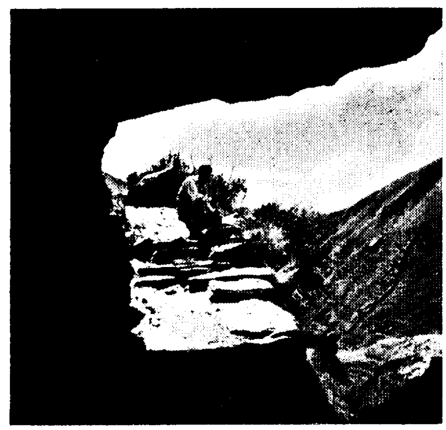


The front of the Badrinath temple.

The party at Badrinath with the priest in the middle.

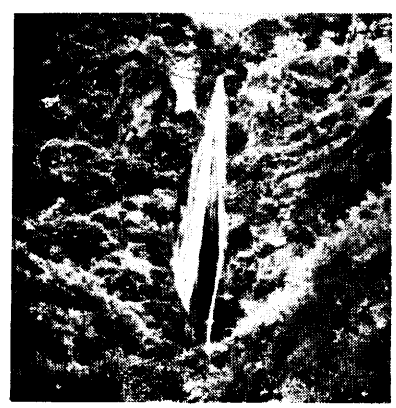
Badrinath village with bare hills around and Badrinath peak.

Old script on a rock beyond Mana, attributed to Pandavas.



Overhanging rock beyond Mana.

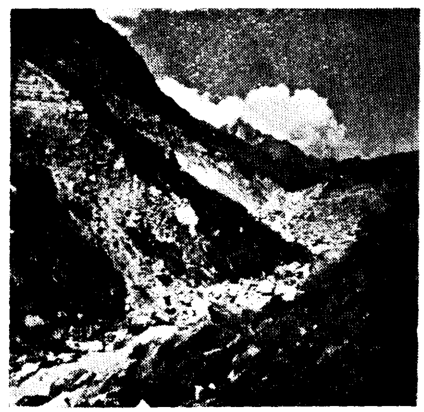
A rock bridging Saraswati river near Vasudhara.



Waterfall.

Waterfalls.

Glimpse of the snows.



Steep bed of the Alaknanda beyond Hanuman *chatti*.

The photographer.

8. There are also Government (P.W.D) Inspection Houses at all these places. These houses are properly furnished, the furniture including beds, some crockery and lamps. Sweepers are locally available. They generally have one bedroom, one bath-room, a small dining-room and a separate kitchen with outhouses for servants. A permit to occupy them can be obtained from the Executive Engineer, Garhwal Provincial Division (Buildings and Roads), Pauri, District Garhwal, U.P. The charges are Rs. 2/- per night.

9. *Season for the pilgrimage*—Badrinath remains covered with snow from November to April. As a result the route is open only from May to October, although, during the monsoon (middle of July to middle of September) land slides are likely to occur which might make the path temporarily impassible. The main pilgrim season is from the middle of May to the middle of June, though some prefer to go from mid-September to mid-October, when the season is very pleasent. The entire route is very clean and there are very few pilgrims and flies, the main scourge during the summer months, are almost completely absent. As personal equipment an ordinary warm coat and 2 blankets are all that are required at night, even at Badrinath itself. As there may be rain, a rain-coat and umbrella are essential.

10. *Means of transport*—Transport has to be hired from Chamoli. Porters and mules are available to carry baggage while ponies and *dandies* can be had by those who do not wish to walk. Very often a porter carries light weight pilgrims (such as old women or children) in a *kandy* (a *ringal* chair) which he straps on to his back. Porters charge Rs. 3/8/- to 4/- per day, and for mules and ponies Rs. 7/- to 8/- per day are charged. A mule carries about 2 maunds of luggage, a load of a maund slung on either side, while a porter carries a load up to 30 seers or 60 lbs.

11. *The journey*—The journey comes under two headings :—

(*i*) The bus journey – from Rishikesh to Chamoli, a distance of 128 miles.

(*ii*) The journey on foot – from Chamoli to Badrinath, a distance of 48 miles.

Note.—The motorable road has now been extended from Chamoli up to Pipalkoti and motors ply up to that place from the summer of 1953.

12. The road from Rishikesh to Chamoli is a narrow mountainous one with only one way traffic. One catches a bus from Rishikesh at 7.30 a.m. and reaches Kirtinagar at 2.00 p.m., walks across the suspension bridge at Kirtinagar, catches a bus for Srinagar and spends the night there. Srinagar is a flourishing town, about 3 miles from Kirtinagar on the motor road from Kotdwara to Chamoli. It also has *Dharamshalas* and a P.W.D. Inspection House. He then takes the bus at Srinagar at 9.45 a.m. and reaches Chamoli at 3.30 p.m. Though the height of Rishikesh is 1,200 feet and that of Kirtinagar about 1,800 feet the motor road ascends to a height of 3,400 feet at Sakinidhar and then decends.

13. On the motor road from Rishikesh to Kirtinagar (about 44 miles from Rishikesh), is the picturesque town of Deoprayag situated at the confluence of the Bhagirathi and the Alaknanda.

Deoprayag is an important place of pilgrimage. Beyond the confluence of these two streams, the river is known as the Ganga.

14. On the motor road to Chamoli, 21 miles from Srinagar, is the town of Rudraprayag. From this town which is situated at the confluence of the Alaknanda and Mandakini, a bridle-path branches off along the Mandakini to the famous shrine of Kedarnath (13,000 feet high), which is a place of extra-ordinary grandeur. The foreground is bare being above the level of vegetation. A majestic temple, sacred to Shiva stands solitary, sheer against a dazzling wall of snow, up which is the legendary Maha Pantha – the path taken by the five Pandavas on their last journey. Continuing on the motor road from Rudraprayag along the Alaknanda,

42 miles from Srinagar is Karanprayag, and beyond this is the town of Nandprayag, 53 miles from Srinagar, with its picturesque narrow street flanked by houses and shops on each side. It is here that the Pinder river joins the Alaknanda and as there is no all weather motor bridge across the Pindar, passengers have, in the rainy season, to tranship across a suspension bridge. Later, when the rains have subsided a temporary motor bridge is constructed.

15. From Chamoli the trek starts. The bridle-path follows the valley of the Alaknanda. The hill-sides are generally steep and bare with small patches of *chir* and *ban* forests here and there while cultivation is confined to the valleys and along gentle slopes in the hills, as far as Joshimath.

16. Cultivation on the hill slopes without proper terracing causes erosion which in course of time destroys the fields themselves.

17. The motor road from Chamoli to Pipalkoti follows the left bank of the river through shady *chir* forests while the bridle-path follows the right bank, which is treeless and barren. The bridle-path from Pipalkoti to Joshimath is fairly well aligned with gentle ascends and descents. Between Pipalkoti and Gulabkoti one gets ones first glimpse of the eternal snows.

18. Joshimath is an important town and has a number of temples. At Joshimath is an effigy of Narsingh, with one hand exceedingly thin. Legend has it, that when *Ghor kalyug* sets in, this hand shall break, and the route to Badrinath will be rendered quite impassable by natural disasters. When the temple at Badrinath becomes snow-bound, the priest moves down for 6 months to Joshimath.

19. From Joshimath the bridle-path descends continuously for about 2 miles to Vishnuprayag where the Dhauli river joins the Alaknanda. The suspension bridge along the Dhauli river is somewhat weak and so the mules should be unloaded before crossing it.

20. The way from Vishnuprayag to Pandukeshwar is very stony and rocky with frequent ascends and descends, although the scenery is rather picturesque. Here across the Alaknanda is a memorial to a Rani who died here as a pilgrim, fortunately after having had *darshan* of Shri Badrinath. It was in the temple here that were found the famous Pandukeshwar copper plates of great archæological value, but whose present whereabouts are unknown.

21. From Pandukeshwar the bridle-path is fairly even for about 7 miles up to Hanuman *chatti* and passes through forests. These forests are the main source of firewood, charcoal and timber for the town of Badrinath. From Hanuman *chatti* where one begins to feel the effects of the altitude, starts the steepest climb of the trek, for about 2 miles up to Deodarshani. From this spot one gets the first glimpse of the town of Badrinath, a mile away and thereafter the path again becomes gentle.

22. The town of Badrinath is situated on the right bank of the Alaknanda river. Here is the famous temple of Shri Badrinath. In the compound of the temple there is a hot water spring which leads to a masonry reservoir (called *taptkund*) which provides pilgrims with a hot bath and hot water for ordinary use. The temple has been recently electrified. The town has a telephone, a posts and telegraph office and a hospital.

23. Unfortunately, all vegetation within a radius of about 3 miles of the town of Badrinath has been almost completely destroyed. As has been stated before, the supply of firewood, charcoal and timber for the town of Badrinath comes from the forests between Hanuman *chatti* and Pandukeshwar. All the hill-tops round Badrinath look bleak and bare. Erosion is common and there are frequent avalanches. Even in early 1952 a huge avalanche destroyed buildings in a part of the town. Consequently the most urgent need of the town is afforestation of the surrounding barren and treeless wastelands. The growth of trees will

not only counteract erosion and reduce the force of the avalanches, but in course of time will also supply the firewood, charcoal and timber requirements of the town. An enterprising business man has succeeded in growing vegetable and fruit on the left bank of the Alaknanda river, opposite the town of Badrinath, showing that the soil is quite suitable for the growth of trees.

24. About a mile beyond Badrinath the valley becomes fairly broad near Mana village, and here can be developed a landing-ground for small aeroplanes.

25. About 5 miles from Badrinath is Vasudhara where there is a very big waterfall. Further up, the Alaknanda river becomes a mere trickle and its glacial formation can be seen.

26. All along the valley of the Alaknanda there are a number of brooks, rivulets and small springs. There are also some picturesque waterfalls and occasionally one gets a glimpse of the snows.

27. The bridle-path is far above the level of the Alaknanda river which is, therefore, generally not visible except from Vishnuprayag and beyond. Here the bed of the river is full of boulders.

28. Above Hanuman *chatti* the bed of the Alaknanda river is rather steep and looks more like the steep bed of a glacier and not the well carved out bed of an old river.

29. *Miscellaneous*—During the months of May and June there are swarms of flies all along the route up to Gulabkoti. A tin of flit and a mosquito net are, therefore, essential. Drinking water should be boiled before use.

30. As the valleys are quite warm during May and June it is advisable to make a move early in the morning, say at 6 a.m. Beyond Joshimath, the altitude acts as a foil to the heat.

31. Fresh supplies of vegetables, fruits, bread, etc., can be arranged by bus from Pauri to Chamoli, a distance of about 80 miles, and then by porters to ones camp. The average speed of a porter is 2 to 2½ miles per hour and so he can be expected to travel 12 to 15 miles per day.

32. Letters can be had, C/o The Post Master at the various halting places (see para 7).

33. In arranging the tour programme, it is customary to have a halt of 3 nights at Badrinath to give rest to oneself and to ones porters and camp followers.

34. A radio, a camera and a box of medicines should form an essential part of the equipment. No fire-arms are required as shooting is prohibited in these religious places.

35. Before starting on this trek it is necessary to be inoculated against cholera and to get a certificate which is to be produced at Srinagar for check.

36. The photographs given in this pamphlet were taken by Sri Kameshwar Sahai, B.Sc. son of the author.

ON *LAKSHADIA FICI*, GREEN, WITH ITS RED AND YELLOW FORMS

BY S. MAHDIHASSAN

Kumar Gupta (1) has recently observed on *Ficus religiosa* at Delhi, a lac insect consisting of red and yellow forms, in the ratio of 3 to 2 respectively. He has not designated the insect scientifically. Ignoring, for the present, all questions of proper nomenclature, attention may be focussed on the most obvious character, the dual forms of the lac insect and search may be made for previous records of a similar observation. In November 1895, Adams (2) was responsible for initiating an experimental introduction of lac from Rewa, on *Butea frondosa* trees at the foot of the Arawalli Hills, in Marwar, Jodhpur State, Rajputana. Being thus interested in lac he records an observation of what appears to be an independent infection ; he, however, writes that "the insect found its way accidentally on to a *pipal* tree, *Ficus religiosa*, and the larvae developed on it simultaneously with those of the other trees (i.e., *Butea frondosa*); but some of them were *brilliant red* while others were *yellow*. .... On (*F. religiosa*) they were in a more advanced stage than those bred on other trees (i.e., *B. frondosa*)". The different stage of the insects on *F. religiosa* and on *B. frondosa*, as observed by Adams, are best interpreted as belonging to two different species, for the insect coming from Rewa was all red, while the Marwari insect, found naturally on *F. religiosa*, was both red and yellow. Adams does not mention the ratio between them but simply gives precedence to red over yellow. Thus, the obvious character or the occurrence of a yellow form, besides the red, and the same host plant specified the insect both at Marwar and at Delhi.

It must have been sometime previous to 1901, when Walsh (3) found a similar lac insect at Monghyr, now in Bihar. It was sent to Watt (4) who, in turn, passed it on to Green (5). Watt (4).writes, in 1901, that "Mr. Green further adds that there are two species of *Tachardia* that afford the lac of commerce in Ceylon. (They are now called *Metatachardia conchiferata* and *Lakshadia albizziae*). It is quite likely, therefore, that India may possess more than two species, and that this circumstance may account for certain discrepencies in the observations of Indian writers that have puzzled practical planters". Watt further adds, that "it will be seen from Mr. Manson's account of the lac insect of the Santhal Parganas that .... there are *several distinct species* of lac insect. .... Again in a sample recently furnished by me to Mr. Green, the insect found was a new species (of *Lakshadia*) : the twigs on which it was found were from *Ficus religiosa*, the *peepal* tree and were contributed by Mr. E. H. Walsh, the Collector of Monghyr". The mention of only one host plant, *F. religiosa*, by Watt may be compared as against two for the same material by Green. Green (5) described the insect in 1903 under the designation *Tachardia* (*Lakshadia*) *fici*. It is interesting to recall that "judging from the dried specimens, it is probable that both *crimson* and *yellow* forms occur, as is the case in the Ceylonese species (*Lakshadia*) *albizziae*". On p. 99 Green (5) gives two host plants for the insect collected at Monghyr, *F. religiosa*, first and then *F. bengalensis*.

A good deal of work was done by Stebbing (6) at Dehra Dun, which was continued by Imms and Chatterjee (7). The Dehra Dun workers do not record any such observation, for they never came across the species, *L. fici*. At Pusa, again, much work was done on the lac insect. On p. 759, Lefroy (8) writes : "The *Tachardinae* include the lac insect of which *Tachardia lacca*, Kerr, is the most important, *T. fici*, Green and *T. albizziae*, Green also yielding lac on a commercial scale. It is by no means clear *which lac is really T. lacca or how many species there really are*". Having thus raised a vital problem, it is surprising that no answer is available even to-day.

In 1923 two papers appeared on the lac insects. One classified the lac insects from a physiological standpoint where I (9) hesitatingly admitted the validity of *L. fici*. Mr. Green had kindly spared me some of his type material but the insects were all red and the only physiological character that specified the insect was thus wanting in this material. On p. 99, I therefore wrote, that "if *T. fici*, Green, should prove to be different from *Lakshadia indica* or the insect found in Bihar on *Z. jujuba* and on *B. frondosa*, then it would be named *Lakshadia fici*". In describing *L. fici*, Green found no characteristic morphological features. He definitely admitted that "this species (*L. fici*) differs from *T. lacca*, Kerr, primarily in the much smaller, more globular and more isolated tests of the adult female. The structural differences of the insect itself are *more of degree than of quality*". In 1923, Chamberlin (10) also published an independent study on the classification of lac insects where he confirmed the species *L. fici*. The type material was the same collected at Monghyr but growing on *F. bengalensis*.

This type material was the same as that of Mr. Green. Green's preferential mention of *F. religiosa* may here be compared with *F. bengalensis* given by Chamberlin. Chamberlin further says, that some of the "material examined (was) part of the type material of Green and a series of specimens from Coimbatore on *B. frondosa* (being) all material received from Green". Although the history of the Monghyr type material is known, the discoverer of *L. fici*, at Coimbatore is not known properly. It may be Ramakrishna Ayyar (11) who as Government Entomologist was, stationed at Coimbatore. Unless the type material actually happens to contain the yellow form besides the red one, which is sure to be there, I should consider the Coimbatore material to represent *L. communis* instead. I have spared myself no pains for a number of years to find the natural infection of lac in South India and I never came across with any other species than *L. communis*. I am inclined to go so far as to say that should the Coimbatore material actually prove to be *L. fici* then it was probably an experimental introduction from outside, for no indication to its history is given. In the case of a lac insect it is not merely necessary to give the locality where it was found. It is essential to indicate the extent of its natural habitat or the real geographical range of its distribution. Lac is found also in Kashmir. Material received from there showed red and yellow lac insects, so that, by 1925, I (12) could confirm the existance of this species cultivated in Billawar Range, Jammu, on *Acacia catechu*. This would be the only source of commercial exploitation of *L. fici*. It was experimentally grown on *B. frondosa*, at Bangalore, and in 1927, I (13) reported that "yellow males and females were nearly four times more than the red ones".

Mr. N. K. Sarkar, of the Lac Research Institute, Ranchi, brought some lac from Jodhpur growing there on *Z. jujuba*. P. S. Negi (14) writes with regard to it, in 1929, that "the Jodhpur yellow Ber lac insect occurs with the crimson variety in a particular locality of the Jodhpur State. The yellow and red varieties both probably breed true to type". No scientific designation qualifies this lac insect inspite of the previous work of systematists, like Green and Chamberlin, not to talk of my own communications upon the insect of which I have no doubt that the species is *L. fici* and first recorded by Col. Adams from Marwar, in Jodhpur. Negi (14) illustrated, on Plate XVI, in Figs. 1 and 2, female lac cells not forming regular chunks but as scattered insects, partly singly, partly in groups of only a few cells. Unfortunately the illustrations are indistinct. It however, fully confirms Green's observation that *L. fici*, shows "more isolated tests of the adult female". This, it may be pointed out, is a feature also shared by *L. communis* which is also a relatively primitive type of lac insect. In 1937, I further published (15) a short note on the Kashmir and Rajputana Lac insect, pointing out the previous omissions of scientifically designating the insect as *L. fici*. Since the species thrives in Kashmir and in Rajputana and has been reported from Monghyr, in Bihar, it is high time that its cultivation should be undertaken. During such attempts of extending its

propagation it may be ascertained if the yellow form breeds true. According to Negi it would do so but my fears point to the contrary. *Coriococcus hibisci*, Green, likewise (16) shows red and yellow dimorphism and the red form predominates.

The lac insects seem to descend from Wax insects. The latter are yellow, with cells widely separated from one another. The lac insect, with its spinoid tubercle, is capable of forming a common colony, as a piece of encrustation. If we compare 100 huts of a village, with 100 rooms of a hotel-building, we at once see the difference between their architectural constitution. Wax insects are only capable of growing close together but not of forming a common honey-comb like encrustation. Thus a tendency on the part of a lac insect to grow separately indicates its primitive character. I have found it only in *L. communis* and in *L. fici* of the Indian lac insects. It is a distinct feature with the pseudo-lac insects, *Tachardina lobata* and *T. silvestrii*, both being even more primitive types. Again, the wax insects are yellow and *L. fici* as well as *L. albizziae* show this tendency. On studying the Chalcid parasites reared from *L. fici* it was found to be mostly attacked by *Erencyrtus dewitzii*. This, as compared with *Tachardiaephagus* sp., which attacks *L. nagoliensis* and *L. mysorensis*, for example, morphologically represents a more primitive insect. Its other favourite hosts are *Metatachardia conchiferata* and *L. communis*, which independently can be shown to be more primitive of their class.

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THE SEASONING BEHAVIOUR OF INDIAN TIMBERS

PART II

(Kiln Drying Schedules)

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INTRODUCTION

As stated in Part I* of these series of publications, the kiln schedule is only a rough guide with respect to the temperature and humidity conditions to be maintained in a kiln when the moisture content of the wettest samples† on the entering air side has reached the stage specified in the schedule. The conditions of drying should actually be regulated in the light of speed of drying, condition of stock with respect to moisture distribution and case-hardening, permissible degrade, quality of material under seasoning, purpose for which the timber is required, type of kiln, thickness of material, and several other factors.

2. The schedules presented in this publication are based on an exhaustive study of kiln drying behaviour of Indian timbers in various types of forced-draft seasoning kilns during the last twenty-two years, all the tests having been conducted by the same individual‡, thus avoiding a variable personal factor in the final grading of timber to a large extent.

APPLICATION OF SCHEDULES

3. The drying schedules§ are commonly given either in terms of time-temperature-humidity or in terms of moisture content-temperature-humidity. The latter form of expression has been adopted in this case, in keeping with the practice in most other Forest Products Laboratories.

4. The schedules, which are conservative and believed to be the safest, are meant for one inch|| thick random sawn timber, of average quality, when seasoned in the forced-draft kilns starting from the green condition. They can be adjusted to get the desired effect in specific cases. For instance, quarter-sawn planks can be dried more quickly than the plain-sawn boards, i.e., they can be given a more drastic kiln schedule. Similarly straight-grained boards free from knots and shakes can withstand more severe drying conditions than poor quality timber. Sometimes a certain amount of degrade in the form of splitting and warping may be considered permissible in order to speed up the drying operation. On the other hand, for special items, such as shuttle blocks and blanks for bobbin manufacture, extra care will have to be taken to get uniform distribution of moisture in different layers of wood and to avoid drying stresses during seasoning process.

5. The schedules are meant for the drying of timber from the green condition. In case partially dried timber is to be kiln seasoned, the schedule can be picked up at the moisture content of the timber in hand, and drying started. It is advisable to season planks

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* Published as *Ind. For. Bull.* No. 154 (Wood Seasoning), and in the *Indian Forester*, Vol. 78, No. 2, pages 81–85, 1952.

† It is desirable to take the average moisture content of the wettest one half of the total number of samples on the entering air side as a guide for making changes in the kiln schedule in preference to one single sample which happens to be the wettest.

‡ The author.

§ The kiln technician who uses these schedules is expected to know the elementary principles of kiln drying and understand the significance of temperature, relative humidity, case-hardening, moisture equilibrium, etc.

|| For timber more than one inch in thickness the relative humidity should be kept 5% higher at each stage during seasoning.

of one species only and of one thickness in one and the same charge. However, if different species and thicknesses are to be mixed, the kiln should be operated so as to suit the timber which is the slowest and the most difficult to dry, out of the lot.

6. As regards the period required for seasoning of various timbers under different schedules, this cannot be given with any degree of certainty, as drying of any timber under any schedule will vary with the type of kiln, particularly with respect to air speed, uniformity or otherwise of drying conditions in different parts of the stack, initial and final moisture contents, etc. The periods given in the schedules are based on the results obtained with modern internal fan kilns having an air movement of about 2 ft. per second on the entering air side of the stack. In a natural draft kiln the drying time taken will be about 50% more. Further, the period of seasoning given under various schedules is based on working the kiln continuously day and night. In case day drying for 12 hours only is resorted to, the period of drying of timber will be 50% more than that required for continuous drying for 24 hours a day. The period of seasoning is not doubled in this case, as a certain amount of moisture goes off from the timber even during night stoppages, since the kiln is hot when closed for the night.

7. While starting the seasoning operation it is desirable to give direct steaming treatment to timber at about 55°C./100% R.H. for about two to four hours. This treatment is helpful in the case of light hardwoods mentioned under Schedules I and II for killing mould growth to which most of these timbers are liable, and it is effective in removing any case-hardening and excessive surface drying in the case of all other timbers, particularly if they are partially air-dried.

8. During the course of the kiln run intermediate moisture tests should be taken to determine the moisture distribution in the outer and the inner layers of timber and to detect the presence of drying stresses, the frequency of these tests depending upon the seasoning characteristics of the species. At least one intermediate test at about 25% average moisture content should necessarily be taken. Each kiln charge should finally be tested for moisture distribution at the end of the run. As regards high humidity treatment, one steaming treatment in the middle and one towards the end, excluding the one in the beginning will be found necessary for most hardwoods, the duration of the treatment again depending upon the severity of case-hardening stresses. Very refractory woods such as those coming under Schedules VI and VII will require more frequent steaming treatment during the course of seasoning.

9. For the purpose of drying timber to a uniform moisture content for high class jobs, like railway carriage building, cabinet work, shuttles, etc., conditioning treatment for complete equalization of moisture in the outer and the inner layers of wood, for removing case-hardening, and for bringing the moisture of the whole charge down to a uniform level towards the end of drying, is desirable. This conditioning or moisture equalization treatment usually consists of running the kiln at about 55°C./70% relative humidity for a day or two. It is estimated that the moisture content of timber will be about 11% at the end of this treatment.

10. The timber should be kiln dried to 10% to 12% moisture content for most purposes in this country. After the seasoning has been completed the charge can be pulled out immediately, if it is desired to save time. If there is no such consideration, it is better to cool the charge for about six hours preferably over-night specially in the case of refractory hardwoods, before the kiln is unloaded.

11. The seven schedules given in this publication are based on the results of analysis of intensive work on about 55 species of Indian timbers representing a wide range of seasoning

characteristics as observed during a detailed study of the seasoning behaviour of about 250 species of commercially important timbers. As more kiln records are analysed the results will be published, and it is expected that the timbers will fall under one or the other of these kiln schedules.

12. As a general rule, light timbers are easier and quicker to season than heavy ones, but seasoning behaviour is greatly modified by anatomical peculiarities and the presence of resins and oils and several other factors. Amongst the Indian timbers there are several which show abnormal seasoning characteristics. For instance there are, timbers which are easy to air-dry but form moisture pockets and get crooked in kiln seasoning, such as *Dipterocarpus* spp. (*gurjun*) ; timbers which are extremely slow to season but do not crack and split, such as *Bridelia retusa* ; timbers which crack even under a very mild drying schedule, such as *Shorea robusta* (*sal*).

13. The problem of kiln drying Indian timbers green from the saw is particularly difficult owing to the refractory nature of several commercially important woods. In America and Australia, where several species of hardwoods are utilized, partial air-drying of the timber before passing it through the kilns has been the standard practice. It is only since recently that the practice of kiln seasoning green timber is being adopted, though even now many conservative manufacturers air season oak planks partially for about two or three months before passing them through the kilns, despite the extra cost and time involved.

14. Since the timber industry in this country is imperfectly organized, the introduction of the method of combined air and kiln seasoning for hardwoods presents many difficulties, both economic and organizational. Here kiln seasoning of timber should better be carried out green from the saw. However, in the case of timbers, which are not at all amenable to kiln drying without partial air seasoning, the method of combined air and kiln seasoning will have to be resorted to. The refractory character of several important Indian timbers puts a limit on the thickness of sawn material for economic kiln drying, both from the green state as well as from a partially air seasoned condition. It is not considered advisable to kiln dry timber more than $2\frac{1}{2}$ or 3 inches in thickness from the green condition. Thicker sections should be kiln seasoned only after partial air-drying to about 30% moisture content. They should preferably be air-dried. Moreover, kiln drying does not offer any great advantage over air seasoning in the early stages of drying, particularly with thick sections of slow drying hardwoods, for which reason also thick sections should necessarily be partially air-dried before kiln seasoning, if the seasoning operation is to be completed in a kiln at all, and if air-drying alone is not acceptable.

15. It may be stated that most of the timbers mentioned under Schedule VII have not actually been successfully kiln seasoned. The loss during kiln seasoning is excessive and the problem of kiln seasoning (in some cases of air seasoning), of some of our refractory hardwoods still needs intensive work for its solution.

KILN DRYING SCHEDULES

*Schedule I**

Tentative schedule for one inch thick planks of *Abies pindrow* (fir), *Ailanthus excelsa, Ailanthus grandis* (*gokul*), *Ailanthus malabarica, Alstonia scholaris* (*shaitan*-wood), *Bombax insigne* (*didu*), *Bombax malabaricum* (*semul*), *Canarium euphyllum* (white *dhup*), *Duabanga sonneratioides* (*lampati*), *Erythrina suberosa, Excoecaria agallocha* (*geon*), *Ficus glomerata* (*gular*), *Gyrocarpus jacquinii* (*punki*), *Lophopetalum wightianum* (*banati*), *Moringa ptery-*

* Reproduced from *Ind. For. Bull.* No. 154 (Wood Seasoning), and *Indian Forester*, Vol. 78, No. 2, pages 81–85, 1952.

gosperma, *Parishia insignis* (red *dhup*), *Picea morinda* (spruce), *Sterculia alata* (*narikel*), *Sterculia campanulata* (*papita*), *Sterculia villosa*, *Tetrameles nudiflora* (*maina*) and *Trewia nudiflora* (*gutel*). Most of these woods are used for packing-case manufacture.

Moisture content of the wettest timber on air inlet side	Temperature				Relative Humidity %
	Dry Bulb		Wet Bulb		
	°C.	°F.	°C.	°F.	
Green	52	125·6	44	111·2	62
60%	55	131·0	45	113·0	55
40%	60	140·0	46	114·8	44
30%	65	149·0	48	118·4	39
20%	68	154·4	48	118·4	33·5

The above timbers will take about 4 to 5 days to season. Almost none of these woods is liable to develop case-hardening, therefore, high humidity treatment is not considered necessary at any stage during seasoning process. However, initial steaming of the charge for about 2 hours at 55°C./100% R.H. should be carried out to sterilize the wood and to kill mould growth.

Schedule II

Tentative schedule for one inch thick planks of *Boswellia serrata* (*salai*)*, white coloured wood, *Mangifera indica* (mango), *Pinus longifolia* (*chir*), *Vateria indica* (*vellapiney*)*. These timbers are commonly used for cheap planking or for moderately heavy types of packing-cases.

Moisture content of the wettest timber on air inlet side	Temperature				Relative Humidity %
	Dry Bulb		Wet Bulb		
	°C.	°F.	°C.	°F.	
Green	45	113	40	104	72
60%	47	116·6	40	104	64
40%	49	120·2	40	104	56
30%	53	127·4	40	104	44
20%	58	136·4	40	104	32·5

The above timbers will take 5 to 7 days to dry. These woods are not liable to case-hardening, therefore, high humidity treatment is not considered necessary at any stage during the seasoning process. However, initial steaming of the charge for about 2 hours at 55°C./100% R.H. should be carried out to sterilize the wood and kill mould growth.

* The dark coloured heartwood of *salai* is extremely slow to dry. In case of *vellapiney* the wood from the inner portion of the log dries more slowly than that from the outer portion.

Schedule III

Tentative schedule for one inch thick planks of *Artocarpus chaplasha* (*chaplash*), *Gmelina arborea* (*gamari*), *Machilus* spp. (*machilus*), *Michelia* spp. (*champ*), *Phoebe* spp. (*bonsum*) and *Terminalia myriocarpa* (hollock). Most of these are light furniture woods.

Moisture content of the wettest timber on air inlet side	Temperature				Relative Humidity %
	Dry Bulb		Wet Bulb		
	°C.	°F.	°C.	°F.	
Green	42·0	107·6	38	100·4	76
60%	45	113	40	104	72
40%	47	116·6	40	104	64
35%	49	120·2	40	104	56
30%	51	123·8	40	104	50
25%	53	127·4	40	104	44
20%	55	131·0	40	104	39

The above timbers will take 8 to 10 days* to dry. In addition to the initial steaming, the timbers will require one intermediate steaming and one steaming towards the end for 2–3 hours at 55°C./100% R.H.

Schedule IV

Tentative schedule for one inch thick planks of *Artocarpus hirsuta* (*aini*), *Chukrasia tabularis* (*chickrassy*), *Dalbergia latifolia* (rosewood), *Dalbergia sissoo* (*shisham*), *Lagerstroemia hypoleuca* (*pyinma*), *Lagerstroemia lanceolata* (benteak), *Pterocarpus dalbergiodes* (Andaman padauk), *Schima wallichii* (needle wood)† and *Terminalia procera* (*badam*). Most of these are furniture woods.

Moisture content of the wettest timber on air inlet side	Temperature				Relative Humidity %
	Dry Bulb		Wet Bulb		
	°C.	°F.	°C.	°F.	
Green	42	107·6	38·5	101·3	80
60%	42	107·6	38·0	100·4	76
40%	45	113	40	104	72
35%	47	116·6	40	104	64
30%	49	120·2	40	104	56
25%	52	125·6	40	104	47
20%	55	131	40	104	39

The above timbers will take 12 to 15 days to season. In addition to the initial steaming, the timbers will need at least one intermediate steaming and one steaming towards the end of drying at 55°C./100% R.H., for about 2–4 hours. For precision drying for high class work, conditioning treatment mentioned in para 9 should be given.

* The quarter-sawn planks of *gamari* are extremely slow to dry. They will take much more time to season.

† Needle wood is liable to serious degrade during drying. It will need at least two intermediate steaming treatments.

Schedule V

Tentative schedule for one inch thick planks of *Adina cordifolia* (*haldu*), *Cedrela toona* (*toon*), *Dipterocarpus indicus* (*kalpine*), *Dipterocarpus macrocarpus* (hollong), *Dipterocarpus turbinatus* (*gurjun*), *Juglans regia* (walnut), *Mitragyna parvifolia* (*kaim*), and *Tectona grandis* (teak). These timbers are used for furniture, constructional work, or for certain special items such as bobbins and other turnery articles.

Moisture content of the wettest timber on air inlet side	Temperature				Relative Humidity %
	Dry Bulb		Wet Bulb		
	°C.	°F.	°C.	°F.	
Green	42	107·6	38·5	101·3	80
40%	45	113	40	104	72
35%	46	114·8	40	104	68
30%	48	118·4	40	104	60
25%	50	122	40	104	53
20%	52	125·6	40	104	47
15%	55	131	40	104	39

The above timbers will take 13 to 16 days to season. Most of these show some abnormal behaviour in seasoning and need careful handling of the kiln. *Toon* is liable to collapse, walnut to honey-combing, *gurjun* and *kalpine* to formation of moisture pockets, and *haldu* developes fine cracks. In addition to the initial steaming, the timbers may need two intermediate and one final steaming at 55°C./100% R.H. for 2–4 hours.

Schedule VI

Tentative schedule for one inch thick planks of *Acacia arabica* (*babul*), *Diospyros melanoxylon* (ebony), light coloured wood, *Grewia* spp. (*dhaman*), *Grevillea robusta* (silver oak), *Ougeinia dalbergioides* (*sandan*), *Terminalia paniculata* (*kindal*) and *Terminalia tomentosa* (laurel). These are heavy planking timbers, most of which are also used for structural purposes.

Moisture content of the wettest timber on air inlet side	Temperature				Relative Humidity %
	Dry Bulb		Wet Bulb		
	°C.	°F.	°C.	°F.	
Green	40	104	37	98·6	82
60%	42	107·6	38	100·4	76
40%	45	113	40	104	72
35%	46	114·8	40	104	68
30%	47	116·6	40	104	64
25%	48	118·4	40	104	60
20%	50	122	40	104	53
18%	52	125·6	40	104	47
15%	55	131	40	104	39

The above timbers will take about 16 to 20 days to season. They need slow and careful drying. The charge will have to be steamed at least twice during the course of drying, in addition to the initial and final steaming at 55°C./100% R.H. for 2–4 hours.

Schedule VII

Tentative schedule for one inch thick planks of *Balanocarpus utilis*, *Eugenia jambolana* (*jaman*), *Hopea glabra*, *Heritiera* spp. (*sundri*), *Shorea robusta* (*sal*) and *Vitex altissima*.

These timbers are highly refractory and it is very difficult to dry them free from defects, particularly from the green condition.

Moisture content of the wettest timber on air inlet side	Temperature				Relative Humidity %
	Dry Bulb		Wet Bulb		
	°C.	°F.	°C.	°F.	
Green	40	104	38	100·4	88
60%	41	105·8	38	100·4	82
40%	42	107·6	38	100·4	76
35%	45	113	40	104	72
30%	46	114·8	40	104	68
25%	47	116·6	40	104	64
20%	50	122	42	107·6	61
18%	52	125·6	42	107·6	54
15%	55	131	42	107·6	45

The above timbers will take about 24 to 30 days to dry. *Jaman* may take about 20 days. The charge will need at least three intermediate steaming operations in addition to initial and final steamings at 55°C./100% R.H. for 2–4 hours.

PROBLEMS OF TROPICAL SILVICULTURE AND MANAGEMENT RAIN FORESTS OF SOUTH INDIA*

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I. INTRODUCTION

The South Indian peninsula, lying between latitudes 8° and 18° North and longitudes 74° and 80° East, has two main mountain ranges ; the Eastern and Western ghats, the former an interrupted chain of hills along the east coast with elevation varying from 1,000 feet to 5,000 feet and the latter an almost unbroken wall along the west coast raising to a maximum of 8,800 feet. The region of the Eastern ghats get an annual rainfall of 20 inches to 40 inches (mostly from the north-east or the retreating monsoon) and supports a vegetation, varying from thorny scrub to moist deciduous forests. The Western ghats areas receive very variable amounts of rainfall ranging from 70 inches to 300 inches (from both the south-west and north-east monsoons) and support a more luxuriant vegetation, from moist deciduous to dense impenetrable evergreen forests with four to six tiers of tree growth. In fact, the Western ghats afford an interesting floristic and ecological study of a typical rain forest, to which these notes are confined.

II. LOCALITY FACTORS

(*a*) *Configuration of the ground*—The Western ghats are formed by a series of parallel ranges which rise from 1,000 feet to 8,800 feet in elevation and are separated by prominent valleys in between, such as the Silent valley, the Lost valley, the Attapady valley and the Shendurney valley. Numerous spurs running across the line of the main ridges can also be seen along the entire length of the ghats. The lower slopes are steep but above 3,700 feet elevation, the terrain becomes an undulating plateau with gentle slopes and a few prominent peaks here and there.

(*b*) *Rock and soil*—The rock formation is of the oldest (Archean) and consists principally of dark granites and their metamorphic (gneissic) variations. The gneiss is finely foliated and is composed mainly of qartz, felspar and biolite, and is occasionally garnettiferous. Further stages of metamorphism are marked by the formation of a horn-blende schist which disintegrates easily. Laterization (which has been attributed to monsoon conditions repeated through the ages) of the parent rock is also noticeable, which in turn results generally in the formation of a ferruginous, argillaceous soil, varying in colour from pale yellow to red. This is the soil on which an evergreen type of forest is found ; and when such soil is fairly deep and well-drained, the evergreen forest thrives best. But in localized depressions where this clayey loam tends to accumulate from rain wash, marshy conditions prevail and in such places the tree vegetation is not rich and only certain species grow well the exclusion of others.

(*c*) *Climate* – (1) Temperature—In the lower regions, the maximum and minimum shade temperatures are in the neighbourhood of 100° and 70°F. respectively, but in the hills the corresponding figures are 90° and 50°F. Frost does not occur at elevations below 6,000 feet. March, April and May are the hot months, but the weather never becomes very cold.

(2) Winds—The prevailing winds are from the west and south-west between April and September and from east and north-east from October to March. The dry east wind blows strongly from November to March drying the forest floor and spreading numerous forest fires.

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* Paper presented to the South-East Asia Forestry Conference, held in Singapore in 1952.

(3) Rainfall—The south-west monsoon, which causes most of the annual rainfall, bursts usually early in June, the heaviest falls following in July and August. The north-east monsoon brings much less rain – about 20–30 inches – in October and November but helps to prolong the season of growth. The following table shows the monthly rainfall during the period 1927–1931 (5 years) at Neelikal, which is taken as a typical locality in the rain forests of the Western ghats.

Statement showing monthly rainfall at NEELIKAL (in inches)

Month	1927	1928	1929	1930	1931	Average rainfall for 1927 and 1931
January ..	..	..	..	..	0·09	0·04
February ..	..	1·22	0·10	..	0·02	0·01
March ..	..	2·67	0·30	0·20	0·62	0·31
April ..	1·23	2·73	7·63	0·25	1·47	1·35
May ..	11·79	4·20	3·14	19·00	5·93	8·86
June ..	40·69	21·33	9·04	18·83	56·05	48·37
July ..	9·351	23·39	13·30	29·20	53·16	73·33
August ..	30·92	30·85	17·91	25·21	107·11	69·01
September ..	37·96	7·82	12·89	31·53	9·93	23·94
October ..	2·70	18·84	18·26	21·33	18·76	10·73
November ..	10·09	5·08	4·35	9·75	13·46	11·77
December ..	..	..	0·45	2·12	3·09	1·54
TOTAL ..	228·89	118·13	87·37	157·42	269·69	249·26

III. FLORISTIC COMPOSITION

(*a*) *Moist deciduous forests*—In the plains and foot-hills up to an elevation of 1,500 feet to 2,000 feet a moist deciduous type of forest is commonly met with. The important species here are *Tectona grandis*, *Dalbergia latifolia*, *Terminalia tomentosa*, *Terminalia paniculata*, *Lagerstroemia lanceolata* and *Xylia xylocarpa* amidst a gregarious growth of *Bombusa arundinacea* and less commonly *Dendrocalamus strictus*.

(*b*) *The rain forests*—Generally speaking, at elevations above 2,000 feet the moist deciduous forest gradually changes to evergreen ; and above 3,000 feet to 3,500 feet the forests become purely evergreen and are referred to as the "Rain Forests". Champion classifies it under VI Moist Tropical Forests – Group 1-A Southern Tropical Wet Evergreen Forests – C3 Western Tropical Evergreen.

"The tropical rain forest formation is characterized by the great luxuriance of its vegetation, which consists of several tiers, the highest containing lofty trees, often with plank buttresses at the base, reaching a hundred and fifty feet or more in height and the lowest containing dense evergreen shrubby undergrowth. A heavy rainfall, high atmospheric humidity, a short dry season, striking absence of gregariousness trees with smooth bark, sparingly branched, leaves often firm, leathery or glossy, thick stemmed climbers, climbing palms and woody or herbaceous epiphytes are characteristic". (WARMING).

The above extract is sufficiently descriptive and would apply generally to the rain forests of the Western ghats.

Trees in the dominant first storey in these forests grow to heights of 100–150 feet and consist of *Cullenia excelsa*, *Machilus macrantha*, *Palaquium ellypticum*, *Mesua ferrea*, *Calophyllum elatum*, *Canarium strictum*, *Dysosxylum malabaricum*, *Poeciloneouron indicum*, *Vateria indica*, *Mangifera indica*, *Polyalthia coffeoides*, *Holigarna arnottiana*, *Elaeocarpus tuberculatus*, *Elaeocarpus munroii*, *Meliosma arnottiana*, *Hopea glabra*, *Mastixia arborea*, *Hemicyclea alata*, *Strombosia ceylanica* and *Filicium decipens*.

The second storey usually includes – *Myristica laurifolia*, *Hydnocarpus wightiana*, *Hydnocarpus alpina*, *Nephelium longana*, *Lansium anamalayanum*, *Garcinia spicata*, *Elaeocarpus serratus*, *Gomphandra polymorpha*, *Gordonia obtusa*, *Canthium didymum*, *Zanthophyllum flavescens*, *Mappia foetida* and *Eugenia* sp.

In the shrubby third storey are generally seen *Enonymus angulatus*, *Agrostachys indica*, *Agrostachys longifolia*, *Eugenia munroii*, *Leea sambucina*, *Clerodendron infortunatum*, *Macaranga roxburghii*, *Strobilanthes* sp. *Laportea crenulata*, *Olea dioica*, *Callicarpa lanata*, *Pavetta zeylanica*, *Vernonia arborea*, *Turpinia malabarica* and *Croton scabiosus*.

The monocotylydons present are *Arenga wightii*, *Pinnga dicksonii*, *Calamus* sp., *Pandanus furcatus*, *Ochlandra beddomii* besides *Elateria cardamomi*, *Curcuma* sp., and some of the *Aeraceae*. Climbers are not as numerous as in the moist deciduous forest. The species commonly met with are *Gnetum scnadens*, *Calamus* sp., *Smilax macrophylla*, *Derris* sp., *Entada scandens*, *Thumbergia mysorensis*, *Morinda* sp., and the epiphyte *Fagrea obovata*.

IV. ASSOCIATIONS

"The tropical rain forest is acknowledged to be a climax formation, representing the farthest advance towards a hygrophilous type of vegetation that a locality is capable of supporting. In such a formation the number of inhabiting species is very large, gregariousness is usually not prominent and associations of a single dominant species are exceptional". In the west coast evergreen forests, such associations of a very few dominant species have, however, been noticed ; and have been ascribed to lack of competition due to edaphic factors, to changes in elevation, aspect or to other special conditions favouring regeneration of certain dominant species. Eight distinct associations have been recognized in the west coast rain forests.

1. The *Cullenia* – *Palaquium* association
2. The *Palaquium* –*Mesua* ,,
3. The *Poeciloneuron* – *Palaquium* ,,
4. The *Mesua* – *Calophyllum* ,,
5. The *Vateria* – *Cullenia* ,,
6. The *Mesua* – *Cullenia* ,,
7. The *Reed* – *Calophyllum* ,,
8. The *Reed* – *Poeciloneuron* ,,

(*a*) *The Cullenia – Palaquium association*—This is the most widespread of all the associations in the region. Usually, it occupies the northern and north-western aspects at elevations between 2,500 feet and 3,500 feet. The dominant species are *Cullenia excelsa* and *Palaquium ellypticum* with sprinkling of *Mesua ferrea* and *Vateria indica*. Good sub-soil drainage and a deep loamy soil are the other factors favouring this association.

(*b*) *The Palaquium – Mesua association*—This association is seen only in the Silent valley (Malabar) and parts of Shendurney valley (Travancore) at elevations between 3,000 feet and 3,750 feet. At higher elevations, *Palaquium* gradually begins to disappear and its place is taken by *Calophyllum elatum*. The co-dominants in this association are *Calophyllum elatum*,

Heritieria papilo and *Artocarpus integrifolia*. The species prominent in the second storey are *Eloecarpus munroii, Cinnamoim zeylanicum* and *Euonymus angulatus*.

(*c*) *The Poeciloneuron – Palaquium association*—This is confined to regions receiving the highest rainfall – 200 to 300 inches per annum at elevations between 3,000 feet and 4,000 feet. The dominant species are *Poeciloneuron indicum* and *Palaquium ellypticum*, with an admixture of *Mesua* and *Calophyllum* in varying proportions. At higher elevations there is a marked decrease in the proportion of *Palaquium* and a corresponding increase of *Mesua*.

(*d*) *The Mesua – Calophyllum association*—Is seen above 3,750 feet and below 5,000 feet elevation. As the elevation reaches 4,500 feet, *Mesua* tends to disappear almost completely but *Calophyllum* continues to be present, through in a stunded form. Above 5,000 feet, the tropical rain forest merges into the sub-tropical evergreens, classified by Champion under VIII Montane Sub-tropical Forests, Group 7-A – Southern Sub-tropical Wet Hill Forests, C-1 – Nilgiri Sub-tropical evergreen forest. Even at elevations above 4,000 feet there is a distinct change in the associated species and the undergrowth. The co-dominants commonly seen are *Litsea oleoides, Litsea stocksii, Gordonia obtusa, Eloecarpus munroii, Cinnamomum zeylanicum, Cinnamomum sulphuratum, Symplocos spicata* and *Actionodaphne bourdiloni*. The undergrowth is usually dense and consists of several species of *Strobilanthus* growing up to twenty feet in height.

(*e*) *The Vateria – Cullenia association*—Comparatively this association is of restricted occurrence, being seen only in certain portions of the Attapady and Bolampatty valleys and parts of Wynaad below 4,000 feet. It is not found in the Silent valley or elsewhere along the Western ghats. A high rainfall, an abundant supply of moisture throughout the year and a high sub-soil water-table (as seen from the network of small streams and rivers in the area) appear to be the factors favouring this sub-type. Almost pure patches of *Vateria* with profuse natural regeneration in all stages can be seen in this locality. The common associates are *Cullenia excelsa, Palaquium ellypticum, Mesua ferrea, Polyalthea coffeoides, Calophyllum elatum* and very rarely *Poeciloneuron indicum*.

(*f*) *The Mesua – Cullenia association*—In places, otherwise favourable for the *Cullenia palaquium* association, when the aspect or elevation becomes unsuitable for the full development of *Palaquium, Mesua* tends to predominate and the *Mesua cullenia* association asserts itself over the *Cullenia palaquium* sub-type. This variation is seen at elevations varying from 3,500 feet to just over 4,000 feet in parts of the Attapady and Lost valleys. A fair amount of *Calophyllum elatum* and sometimes *Aerocarpus fraxinifolius* (of large size) are also to be found.

(*g*) *The Reed – Calophyllum association*—"This community is a localized edaphic climax, situated within a wider association". In the Silent valley and Shendurney valley (Travancore) there are stretches of marshy land where small streams stagnate for nearly nine months in the year. The ground is a series of pits and mounds probably caused by the impeded flow of water. Such sites are characterized by a dense and gregarious growth of reeds (Ochlandra) while on the mounds are seen *Calophyllum elatum, Hopea glabra, Eugenia* and *Bischofia javanica*. The pit and mound formation apparently helps the regeneration these species as the mounds afford the necessary drainage to prevent the rotting of young seedlings. The rainfall is not high and *Poeciloneuron* is conspicuously absent.

(*h*) *The Reed – Poeciloneuron association*—"This is another edaphic climax prevailing under conditions of heavier rainfall, where the soil is inclined to be marshy". This sub-type is very much similar to the one described above except that in addition to *Calophyllum*, there is also a preponderance of *Poecilonuron* in the dominant crop due mainly to the higher moisture conditions. It is common in certain parts of the Silent valley and in Shendurney valley.

V. FORESTRY PROBLEMS

A. Silviculture

(*a*) *The growing stock*—The floristic composition described in the preceding paragraphs will clearly indicate the complex nature of the vegetation and also point to the numerous problems to be solved in the management of these forests. Of the fifty or more species of timber trees in these evergreen forests, hardly a dozen are of any economic importance up-to-date. They are *Mesua ferrea, Poeciloneuron indicum, Calophyllum elatum, Hopea parviflora, Dysoxylum malabaricum, Vateria indica, Machilus macrantha, Lophopetalum wightianum, Cullenia excelsa, Palaquium ellypticum* and *Acrocarpus fraxinifolius*. Due to the great admixture of species in the rain forests, the incidence of the valuable species is so small that comparatively large areas have to be worked to meet the demand.

(*b*) *Silvicultural character and requirements*—Secondly, the silvicultural characters and requirements of the species vary so much that it would be almost impossible to apply a uniform treatment even over limited areas. While *Palaquium, Mesua, Poeciloneuron* and *Hopea* are extreme shade bearers and the seedlings can withstand the suppression from weed or shrub growth, for a number of years, *Dysoxylum, Calophyllum* and *Vateria* want not only more light, but cannot withstand weed competition in the early stages. Again species such as *Hopea, Cullenia, Palaquium, Vateria* and *Poeciloneuron* seed every year and regenerate profusely, but the seeding of the other species is extremely irregular and what is more, special conditions such as a loose soil, absence of weed competition and timely rainfall appear to be necessary for their germination. For example, *Mesua* and *Dysoxylum* may seed only once in three, five or sometimes seven years ; and it takes 13 to 15 months for the fruits to ripen (as against 3 to 5 months for other species). Further, the seeds and the tender cotyleydons of *Mesua, Dysoxylum* and *Palaquium* are eagerly sought after by rats, mouse deer, squirrels, porcupines and numerous insects. Lastly, the oily seeds of *Vateria* and *Palaquium* lose their viability in a very short time and unless conditions favourable for their germination prevail a week of the seed fall, there may be little or no regeneration.

Such varying silvicultural characters naturally have resulted in the preponderance of certain species (and certain age classes) and in places even to the almost total exclusion of the others. For instance, while there is profuse natural regeneration (and fairly even distribution of the various age classes) of *Poeciloneuron, Cullenia* and *Palaquium*. Seedlings of species such as *Dysoxylum, Mesua* and *Acrocarpus* (and to a lesser extent *Vateria*) are considerably less in evidence ; the species being represented only by the mature or over mature age classes. This is particularly the case with *Mesua* and *Dysoxylum* and is indicative of a set back due to competition from more hardy and shade bearing species like *Poeciloneuron* and *Cullenia*.

(*c*) *Results of silvicultural experiments*—It has already been indicated that some of the species like *Hopea, Palaquium* and *Cullenia* are very good shade bearers and can withstand intense weed competition for a number of years. But experiments conducted since 1930 on the light requirements and tending of evergreen species have shown that even these species do require more light and freedom from weed competition if they are to pass successfully and speedily from the unestablished to the established stage and finally to the sapling stage. *Hopea, Cullenia* and *Palaquium* benefit significantly by two weedings a year in the early stages ; and at the pole stage, removal of the lower and middle canopies results in a significant increase in the height growth. In the case of the more light demanding species like *Mesua, Dysoxylum, Vateria* and *Acrocarpus*, it is seen that right from the start, weeding, raking of the soil and gradual opening of the canopy all help noticeably in taking the tender recruits progressively to the sapling stage. The most valuable species in the rain forest is *Dysoxylum malabaricum* (the Malabar White Cedar) and admittedly it happens to be the most difficult

to regenerate. Clearing the undergrowth around the mother trees, raking the soil just before seed fall, coating the seeds with red lead to prevent them from being destroyed by Vermin and two weedings during the first year, all have resulted in increasing the percentage of germination significantly in the case of *Mesua* and *Dysoxylum*. Thereafter, weeding once a year just after the south-west monsoon and tending (removal of saplings and poles interfering and less valuable species) at three-year intervals have been significantly beneficial. At the pole stage they can stand the shade or no more than the top canopy.

B. Management

The complex nature of the vegetation and the uneven distribution of the age classes, together with the danger of prolific weed growth, have necessitated the working of the evergreen forests under some form of the Selection system only. The limited number of the valuable species, the preponderance of mature and over-mature stems and the absence of regeneration and poor representation of the younger age classes in certain species like *Mesua*, *Dysoxylum* and *Vateria* have narrowed the field of selection still further in their favour. Besides a longer felling cycle than what would otherwise be actually necessary, has to be adopted. In fact, only 3 to 5 trees per acre are felled in these forests and consequently a very large area has to be worked annually to meet the demand.

In removing the large trees, not only are numerous poles and saplings of valuable species damaged but large gaps are also created, sometimes two to three square chains ; and the immediate consequence is the prolific growth of such persistent weeds as *Elateria cardamomi* (cardamom) *Laportea crenulata* (Devils' nettle), *Lea sambucina*, several species of *Strobilanthes*, *Trema orientalis*, *Macaranga peltata* and *Mesa parrotitiana*. In this sea of weeds, the young recruits of *Hopea*, *Poeciloneuron*, *Palaquium* and *Cullenia* may survive for a year or two, but the other species have scarcely any change. Usually the fellings start in September and continue till the end of May of the following year. From experiments conducted during the last twelve years, it is seen that a weeding immediately after the south-west monsoon, followed by a tending in which the damaged poles of valuable species are coppiced and the saplings of undesirable species cut, results in a significant increase and growth of the regeneration on the ground. But due to the extensive area worked every year, in practice this operation proves difficult and can not be completed successfully.

C. Utilization

As indicated in para 5(*a*) above, although the number of inhabiting species in the evergreen forests is large, even now the number of valuable species is disproportionately small. In fact, before world war II, only *Mesua*, *Poeciloneuron*, *Hopea*, *Dysoxylum* and *Calophyllum* were extracted ; the first two for railway sleepers and the others for timber for construction purposes and cabinet making. During the war, especially after the Japanese occupation of Burma and the Andamans, there was an extra-ordinary demand for timber of all kinds, particularly those suited for packing cases, plywood and the match industry, and species such as *Cullenia*, *Palaquium*, *Vateria*, *Machilus* and *Lophopetalum* began to be exploited in larger quantities. The demand for these species has continued even after the war but still the number of marketable species is hardly twelve. The difficulties of terrain and the very limited number of trees available per acre, have made modern mechanized extraction almost impossible. American lumbering methods were tried in portions of the area about 30 years ago, but failed completely. The steep slopes of the foot-hills, the undulating nature of the plateau and the innumerable steams originating from the area, have made road marking a very costly and difficult operation. Due to the lack of suitable fodder, even elephants do not thrive and practically all the timber is brought down to the roadside by human labour. To make the problem

more complicated a very severe type of malaria is prevalent in the area and labour is not readily available for working in it.

VI. Conclusion

Although the correct forestry practice to be adopted in working the tropical rain forests still remain to be determined, these forests constitute a valuable treasure house ; and systematic research into the Silvicultural and technological problems involved will lead to immense benefit to the people. Helpful to the solution of these problems to a great extent are the efforts of the World Health Organization resulting in large areas of evergreen forests becoming practically free from malaria and to that extent the labour problems has eased. With modern road building equipment, roads have been built throwing open vast areas and making extraction of timber easier and cheaper. During the last twenty years, valuable data on the silvicultural characters and requirements of the various species have been collected and the problem of regenerating them is much nearer solution. Lastly, with the progress of research on the various aspects of wood technology, many more species in the evergreen forests will become valuable. It is, therefore, to be hoped that along with other evergreen forests of the world, the "Silent valley" of Malabar, may also hum in the near future with the bustle of human activity.

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STATISTICAL METHODS IN FOREST RESEARCH*

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SUMMARY

The paper reviews the efforts made in the application of statistical methods to forest research in India during the last two decades and points out some of the common defects in experimental design and in the analysis of data of silvicultural experiments.

The potentialities of factorial designs, incomplete blocks, etc., in the planning of silvicultural research are pointed out.

The need for closest collaboration between research foresters and mathematical statisticians for exploring possibilities of replacing subjective free-hand curves by objective regression analysis in the evaluation of data for preparing yield and volume tables is stressed.

Recent work on the technique of statistical sampling for timber surveys has been reviewed.

Finally, some suggestions are given for raising statistical standards in forest research by international effort.

The position in India in regard to efforts made in the application of statistical methods to forest research was summed up by Ranganathan (1950) in the course of a paper presented to the United Nations Scientific Conference on the Conservation and Utilization of Resources held at Lake Success in 1949. To quote his words :—

"The publication of an Experimental Manual for India by Champion in 1931 in pursuance of a recommendation of the Silvicultural Conference of 1929 marked the starting point in standardizing methods of experimental research in Indian Forestry. The importance of statistical analysis was recognized by the inclusion of a chapter on statistical methods in the Manual. The Fourth Silvicultural Conference held at Dehra Dun in 1934 discussed methods of statistical analysis of data collected in the course of silvicultural experiments. Between 1934 and 1939 considerable progress was made in the Forest Research Institute in the study of statistical methods of design and analysis of experiments. Two Statistical Assistant Silviculturists were sent in 1936 and 1937 to the Indian Statistical Institute, Calcutta, for special training under Prof. P. C. Mahalanobis, F.R.S. As a result a clear exposition of the principles and methods involved was presented to the Fifth Silvicultural Conference in 1939, which resolved that the chapter on Statistical Methods in the Experimental Manual should be re-written so as to include the latest advances made in statistical analysis and experimental design.

"The Sixth Silvicultural Conference held in 1945 resolved that in view of the great developments that had taken place in statistical science since Champion wrote the chapter on statistical methods in 1931, a separate Statistical Manual dealing with principles of design and analysis of forest experiments should be produced. Accordingly Griffith and Sant Ram published in 1947 the 'Statistical Manual' as Vol. 2 of the revised Silviculture Research Code.

"A further step forward in this direction was taken in 1947 through the creation of a Statistical Branch in the Forest Research Institute, Dehra Dun, with a highly qualified and experienced Statistician (in the person of Dr. K. R. Nair) at its head. A short refresher course for provincial Silviculturists in statistical principles of design and analysis of experiments was conducted in 1948 and it is hoped to make this a regular annual feature".

* Paper presented to the Sixth British Commonwealth Forestry Conference held in Canada during August – September, 1952.

Besides the annual statistical training course for provincial silviculturists and their assistants, it was decided to include statistical methods in the syllabus of the Indian Forest College at Dehra Dun. Commencing from 1949–50, regular courses of lectures are being given on the subject to the officer-trainees in this College. It is hoped that in course of time every forest officer in the land will have a clear notion of the use of statistical methods in forestry. An editorial article in the *Indian Forester* of March, 1951 stresses the importance of statistics in forestry and urges the younger generation of forest officers to learn enough statistical methods to enable them to statistically design, analyse and interpret silvicultural experiments. In the same journal, Banerji (1938) gave an instructive article on how the methods of experimental design and statistical analysis developed by Fisher for agricultural field experiments could be applied to silvicultural experiments.

DEFECTIVE DESIGNS

The common defects in silvicultural experiments conducted in the past had been lack of replication and scant respect for the principle of randomization. In many experiments only a single plot was used for each treatment with the result that there was no means of separating treatment effects from the inherent effects of soil heterogeneity. Even where replicated plots were used their number was too small to obtain a reliable estimate of the experimental error variance. For instance, a single 3×3 Latin square has often been used to compare three treatments giving only 2 degrees of freedom for estimating error variance.

Wherever a Latin square was used it had been a systematically arranged square, as for example,

A	B	C	A	B	C	D	A	B	C	D	E
B	C	A	B	C	D	A	B	C	D	E	A
C	A	B	C	D	A	B	C	D	E	A	B
			D	A	B	C	D	E	A	B	C
							E	A	B	C	D

There are 12 ways of writing down a 3×3 Latin square, 576 ways of writing down a 4×4 Latin square and 161280 ways of writing down a 5×5 Latin square. It is not generally known that the experimenter is expected to choose one at random out of the different possible squares of a particular size, 3×3, 4×4, etc. There is a simple way of selecting a Latin square at random (see Fisher and Yates 1948). As a reminder to experimenters that randomization of treatments is required not only for 'randomized blocks' but also for 'Latin squares' it is desirable to refer to the latter design as 'randomized Latin square'.

Banerji (1938) had rightly criticized the practice of laying out plots of silvicultural experiments in the order ABC, CBA, ABC, CBA,...... or ABCD, DCBA, ABCD, DCBA,...... or ABCDE, EDCBA, ABCDE, EDCBA,...... etc., and had stressed the importance of randomization of treatments among the plots of a block. The whole experiment should occupy as far as possible a compact area and not be in a single line.

ANALYSIS OF EXPERIMENTAL DATA

In agricultural field experiments, the character studied is usually yield of a crop per plot or unit area which can be determined by a single harvesting process and hence not requiring the yield of each individual plant inside a plot to be recorded. In forest research, on the other hand, we have invariably to take observations on each individual plant first to record whether it is living or dead, and secondly, if living, to measure height or diameter or both,

This basic requirement of having to record observations for each plant has led to the widespread use of individual plants as experimental units in forest nursery experiments.

Thus, in an experiment involving say five treatments and using say 50 plants for each, it is a common practice in India to use a design with 50 randomized blocks, each randomized block having only one plant of each treatment. Some of these plants may die and one of the objects of the experiment is to compare the survival % for the five treatments. This comparison is performed by a chi-square test after tabulating the data in the form of a 2×5 contingency table :

Treatment	Number living	Number dead	Total
1	..	..	50
2	..	..	50
3	..	..	50
4	..	..	50
5	..	..	50
TOTAL ..	..	..	250

The above test takes no notice of the fact that a randomized block design was used. Only if we can assume that there is no difference in survival rate between blocks, will the above test be strictly valid. Wherever such an assumption is not justified, the test will give erroneous conclusions. It is only recently (Cochran, 1950) that a test (called Q-test by him) has been developed which is directly applicable to our problem.

Besides survival % it is necessary to compare the development of the surviving plants. According to the usual practice the mean heights of the surviving plants for each of the 5 treatments in the above experiment will be compared in pairs by the t-test, ignoring the existence of blocks in the experimental design. Actually the height data require two-way classification according to blocks and treatments. Since deaths have occurred the height data for some of the cells of the two-way classification have to be taken as missing. The data become non-orthogonal with regard to blocks and treatments, i.e., the block effect and treatment effect can be separately estimated only by analysing the data by 'fitting of constants' (see Yates 1934, Nair 1941).

Instead of a single plant as experimental unit, if a row or a lattice of a definite number of plants is used as the unit of experimentation for each treatment, the number of replications will no longer be the number of plants but the number of such units. Thus, if we have 100 plants of each treatment, we may take as experimental unit 20 plants arranged in a lattice of 4×5. We will then have 5 replications for each treatment. If there are 5 treatments, these replications can be arranged in either 5 randomized blocks or in a 5×5 Latin square.

The number of survivals in each unit may be 0, 1, 2, ...or 20 and the proportion of survivals 0, $\frac{1}{20}$, $\frac{2}{20}$, ...$\frac{19}{20}$ or 1. There will be 25 proportions to deal with as there are 25 plots. Since these proportions do not satisfy the normal law implicit in the analysis of variance, it has been found by Bartlett (1936) that the following inverse sine transformation

$$x = sin^{-1}\sqrt{p}$$

where p is the proportion of survivals in each experimental unit is necessary and that the analysis of variance has to be performed on x.

The analysis of mean height of surviving plants per unit will again present difficulty owing to these means being of unequal precision based as they generally are on unequal number of surviving plants.

STUDY OF GROWTH

Another feature which distinguishes forest nursery experiments from most agricultural field experiments is that in the former the survival and height are recorded for a number of years (at least three growing seasons) whereas in the latter, while dealing with annual crops, only one observation, namely, the yield at time of harvest, has to be taken. It becomes possible and necessary, in the former case, to determine rates of growth of individual plants and to compare the mean rates of growth for different treatments. This involves the fitting of regression curves of height on age and analysing the coefficients of these curves for detecting differences ascribable to treatment effects.

Just as in animal feeding experiments where it is difficult to have animals of the same initial weight, it is seldom possible to start a forest experiment with plants of the same initial height, diameter, etc., even though they may be of the same age. The differences in rates of growth of individual plants are likely to be very much influenced by the differences in initial height, diameter, etc. The method of covariance analysis (see Wishart, 1939) will be a useful tool to adjust for these initial differences in height, diameter, etc.

The determination of growth curves of trees of various species over their whole span of life is one of the main problems of forestry. Prediction of height, diameter and volume of individual trees at various ages and of yield of a forest under different systems of management (thinning regime, etc.), are of primary importance. The traditional method of curve fitting in this problem has been free-hand drawing. The idea that mathematical curves fitted by the method of least squares is unsuitable is firmly rooted in the minds of the great majority of forest officers. There had been attempts to break away from this tradition by some enterprising forest officers with encouraging results (for instance Näslund 1936 and 1942, Raghavan 1948). The present author was particularly fascinated by the curve

$$y = c + \frac{x^2}{(a+bx)^2}$$

used by Näslund to specify the regression of height on diameter. y is height, x is diameter at breast height and c is the breast height taken as 1·3 metres in Sweden, corresponding to $4\frac{1}{2}$ ft. taken in India. If this curve is a good fit, the set of points obtained by plotting $\frac{x}{\sqrt{y-c}}$ along y — axis and the diameter along x — axis should lie almost on a straight line. One can visually judge this in most cases and then proceed to fit a straight line by the method of least squares thus determining the constants a and b of the curve.

The curve developed by Näslund closely resembles the logistic curve of population growth developed by Raymond Pearl (1930).

In the study of growth in diameter of trees with increase in age one pertinent factor is the changes in width of annual rings and the extent to which these changes are influenced by climatic factors like rainfall, etc. Schumacher and Mayer (1937) made a pioneer study of this question using the elegant method of regression integrals developed and successfully applied by R. A. Fisher (1924) to the study of influence of rainfall on yield of wheat at Rothamsted.

From the studies cited above it is quite clear that there is considerable scope for application of statistical methods to determine growth curves. The whole procedure of preparing

yield and volume tables consists of intricate determination of curvilinear relationships. By co-operative effort between foresters and mathematical statisticians much more could be achieved. It may even be that such an effort will help evolve a unified system of growth curves in the same way that frequency curves were brought under a unified system by Karl Pearson.

Director M. Näslund of the Swedish Forest Research Institute wrote as follows in an article published in *Research*, Vol. 3, No. 7, July 1950, p. 325.

"The application of statistical methods, particularly regression and variation analysis to the problems of advanced forestry research has had most successful results. Therefore, a special department for mathematical statistics has been set up to serve the various divisions of the institute with statistical analysis of experimental results".

USE OF FACTORIAL AND INCOMPLETE BLOCK DESIGNS

Banerji (1938) made an enthusiastic plea for the use of factorial designs, confounding and incomplete block designs in silvicultural experiments.

By and large, silvicultural experiments in India have been of the single factor type. But factorial designs have also been used. The earliest to my knowledge is a plantation experiment conducted in the Kulu Forest Division, Punjab in 1939 with the following factors and their variants.

Factor A :	(1)	Stump *vs.* (2) Branch cutting.
Factor B :	(1)	Horizontal *vs.* (2) Vertical planting.
Factor C :	(1)	Soil treated with lime.
	(2)	Soil treated with wood ash.
	(3)	Soil with humus removed.
	(4)	Control.

The total number of treatments was $2 \times 2 \times 4 = 16$.

Guillebaud (1948) in his Presidential Address to the Society of Foresters of Great Britain said as follows :—

"In the 1930's we in this country at least were content with simple Latin square and randomized block forms of lay-out, and it was only recently that under the stimulus of Dr. E. M. Crowther of Rothamsted we began to realize what a powerful weapon the factorial technique places in our hands and how much more efficient and economical in ground and effort experiments with possibly interacting factors become when the factorial method of lay-out and analysis is employed".

Banerji's suggestion for use of incomplete block designs in silvicultural experiments was none too early. In the U.S.A. such a design was used for an experiment in forest genetics involving 729 strains of *ponderosa* pine (see Day and Austin, 1939). It is remarkable that even in large scale varietal trials in agriculture for which these designs were first developed by Yates no experiment has so far been done with such a large number of strains or varieties as used in this forest genetic experiment (see Cochran and Cox 1950).

Forest genetics has yet to make its debut in Indian forest research. The use of incomplete block designs will be realized when research in tree-breeding makes some head way.

Use of these designs is by no means confined to tree-breeding research. In a recent silvicultural experiment conducted in this Institute there were four treatments to be applied to individual trees. Sets of four comparable trees were not available but it was possible to

form pairs of them so that the two trees of each pair were comparable in diameter, height, crown, etc. Hence a balanced incomplete block design was used for this experiment.

STATISTICAL SAMPLING

Forest surveys throughout the world adopt sampling methods. The statistical requisites of efficient sampling as applied to forestry have been recently studied by Finney (1947, 1948 and 1950) using mostly data made available to him from India. His first two papers have been reproduced as an *Indian Forest Bulletin.* Although for the data examined, systematic sampling proved more precise than stratified random sampling, Finney recommends the latter method of sampling (with at least two sample units per stratum) since no assessment of the sampling error is possible in the former method.

Recent work by Yates (1948) has given some theoretical guidance on how to assess an upper limit to the error of a systematic sample. Yates states that his investigation "confirms that no method of obtaining a really valid estimate of error from the sampling results can be hoped for" in systematic sampling.

The sample units by Finney were complete strips. In many countries small circular plots have been used as sample units located at regular intervals on equidistant lines. The plots, therefore, form a regular grid or lattice. Matern (1947) and Yates (1949) have examined methods of estimating the precision of such systematic line-plot surveys. Indian experience in the use of line-plot surveys has been discussed by Nair and Bhargava (1951).

DEVELOPMENT IN THE COMMONWEALTH AND OTHER COUNTRIES

The development of modern statistical methods has been largely the work of two renowned English statisticians, Karl Pearson at University College, London and R. A. Fisher at Rothamsted Experimental Station, a fact on which the Commonwealth can justly feel proud. But so far as application of these methods to forestry goes, countries outside the Commonwealth, for instance, U.S.A. and Sweden, have advanced farther ahead. Schumacher (1945) has given a comprehensive review of the extent to which statistical methods are used in the United States. A committee of the American Society of Foresters recently prepared a report on the need and usefulness of statistical methods in Silvicultural Research. This report was published in the *Journal of Forestry,* October 1950 and reproduced in *Unasylva,* January–March, 1951.

The application of statistical methods to forestry is not a problem for the Commonwealth alone. In order that proper statistical standards are set up and maintained in forest research throughout the world, this conference may pass a resolution recommending to the International Union of Forest Research Organizations to set up a separate section to examine this question and to explore ways and means of educating the forester in modern statistical methods. Professor Dr. H. Leibundgut, the Leader of Research Section 23 of the I.U.F.R.O. has already made a good beginning in this direction. In the course of a communication reproduced in *Indian Forester,* April 1951, pp. 277–80, he writes as follows :—

"In various quarters the proposal for *standardization of research methods* was particularly welcomed, and the desirability of paying greater attention to the development of a sound basis for the statistical analysis of results of experiments was urged. As a matter of fact, the results of many silvicultural tests will not stand up to such examination".

He then communicates the views expressed at his request by Prof. Dr. Linder, Reader in Statistics at the Federal Institute of Technology in Zurich, as to the general statistical principles of experimental design with reference to a typical silvicultural investigation.

Prof. Leibundgut closes his letter with the remarks :—

"In many instances, statistical interpretation of the experimental material will not be possible in silvicultural experiments. In the meantime, therefore, further information on the inductive basis of experimental projects and details as to whether results have been statistically checked and confirmed would be particularly desirable".

This conference may also consider requesting the U.N.O. and its specialized agencies UNESCO and FAO for setting up international statistical training centres for foresters in different regions of the world. The Conference may also consider adding a separate section on statistical methods in the *Forestry Abstracts* and entrusting the work of abstracting to one or more leading experts on forestry statistics.

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NAVAL STORES INDUSTRY

BY O. N. MUTTOO

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This term is applied to the industry producing turpentine, rosin, pine-tar and other products from the pine tree. It has been a long time in use since the principal products of this industry were pitch and pine-tar, used for caulking wooden ships and weather-proofing the 'line', from which the industry derives its name.

Prior to 1900, turpentine was considered as the principal product of pine-gum, rosin being regarded a bye-product. Subsequently, uses of rosin were developed and to-day modern researches have shown such great possibilities for this material that it is now suggested that the name of the industry be changed to 'Rosin Industry'.

SOURCES

The sticky material exuding from the pine trees – called gum, resin or oleo-resin – has been known to man since antiquity and used in every day life in the areas where found. The two basic products derived from pine-gum were turpentine and rosin and were for many years processed in crude fire stills.

Originally turpentine was produced from living pine tree. To-day, there are other methods of production from a second source; viz, roots and stumps, – commonly named 'Torchwood' or 'Chilka' – and the products depend on the method employed. A flow chart of the industry is attached to indicate the various products obtained by different methods.

As there is no pine-wood, distillation industry in our country, the gum aspect of the industry alone will be discussed in this note.

SCOPE FOR DEVELOPMENT

This industry offers immense scope for development in our country and to occupy a world place. It can be developed as a source of earning considerable foreign exchange. Unfortunately it has not yet received adequate attention from the state. The industry has been worked as individual manufactories yielding a certain income to forest revenues and the object has been to maintain this revenue.

America is the world's largest producer of Naval Stores, France, Portugal, Spain, Sweden and Mexico coming in order of production. Russia which entered this industry shortly before war, is now well advanced but no figures of production are available.

Approximate world production by countries of Rosin (in lacs of pounds) and of Turpentine (in lacs of gallons) is noted below :—

	1949		1950	
	Rosin	Turpentine	Rosin	Turpentine
U.S.A.	10,482	332	10,787	346
France	1,221	46	1,235	46
Portugal	949	32	948	31
Spain	772	31	728	28
Mexico	441	13	525	17
Greece	182	7	224	8
Sweden	55	28	66	30
Others	84	8	136	11

Indian production may be taken as about 3 lac maunds of rosin and 6 lac gallons of turpentine.

It is noteworthy that prior to 1930, almost all the rosin and turpentine, produced in U.S.A. was the work of 1,000 crude fire stills, scattered over the forest, while this factory had a 'then modern' steam distillation equipment. Revolutionary improvements have since been effected in the collection, handling, cleaning and processing of pine gum and its products but our methods have not improved on account of which, our overall quality to-day is poor, yields are low and costs are high.

It is clear, therefore, that the subject needs technical investigation and the results are not difficult to be achieved.

Collection of Gum

The process of collecting the gum is a simple one; yet to obtain the best results and to deliver it in a fresh condition to the processors, it has to be carried out according to a scientific technique. Most of the gum processed in this country comes from Government and Quasi-Government forests where extraction is carried out according to age old methods. Due to this the quality of gum has gone down and on account of this the production of high grades of rosin has also been reduced. The development of the industry calls for improved method of collecting the gum and of delivering it in a clean and fresh condition for processing. This requires training of the *mazdoors* and forest staff in the technique of collection.

The usual method of collecting the gum is by chipping or wounding the tree, technically termed 'streaking'. Streaking is usually done during a 32-week season, from spring to fall, once a week, with a streak 0·5 inch high and 0·5 inch deep. The face should be limited to not more than one-third the circumference of the tree or 14 inches in width. It is started as near the base of the tree as a pot can be hung and is extended upward over a period of time to a height not to exceed 100 inches. Acid stimulation, using 40% to 60% solution of sulphuric acid, is the modern practice in which case streaking need be done only twice a month to obtain the same or a slightly better yield. The exudate is collected by means of gutters and pots and the pots are emptied into receptacles.

Forest operations have been studied in detail, by modern science and in principal Naval Stores countries, a branch of Forest Service is specially trained and deputed to advice the gum farmers on the scientific methods of collecting the gum. In India since the collection is carried out departmentally by state Governments, it is easy to effect improvements on an organized basis.

Processing of Gum

Fire still—Formerly crude pine gum, just as it arrived from jungle, was dumped directly into fire stills. It was impossible to make good quality rosin or turpentine by this method. The discharged rosin was dark and the quality of oil inferior. Besides the financial loss, the products of fire still were unsuitable for use in a variety of manufacturers for which their chemical composition makes them highly suitable.

Batch still—Fire still was subsequently replaced by the steam batch still and this type of equipment, called Ropar process, was first developed and largely used in France. When the industry was started in India, in 1918–1920, Ropar (French) stills were put up in both the then Government factories at Jallo and Bareilly – Jallo has now gone to Pakistan – and the units laid were the smallest conceivable. Subsequently when the demand increased, the production was increased by adding similar units to the extent space permitted.

Since the establishment of steam batch still, the aim of the industry has been to develop a continuous still whereby rosin and turpentine could be produced in one operation. The Ropar process was wasteful in the matter of labour charges and steam consumption, which were the two principal items of expenditure in the processing of gum.

Continuous still—Years of persistent research by Naval Stores scientists brought out a continuous still and this changed the entire working aspect of the industry with regard to cost of working and the quality of products. This still was in use in France and Belgium but was not yet put in commercial use in U.S.A. It was of simple construction and very economical in the matter of steam consumption and labour charges. It employed the use of vacuum which facilitated the fractionation of various grades of turpentine in the first operation.

Improved batch still—Apart from continuous still, remarkable improvements have been effected in the batch still making it highly efficient, economical and labour saving. Bulk of the production of rosin and turpentine in all the countries is at present turned out by these stills.

Gum refining—Another remarkable work which brought about rapid modernization of Naval Stores Industry, was the commercial refining of gum. According to this process, (in U.S.A. this is known as Olustee process), the gum undergoes a process of refining before it is processed as a result of which brilliantly clean rosin is obtained. Rosin produced out of uncleaned gum is hazy owing to the presence of trash which cannot be eliminated by ordinary methods of filtration and settling. The superior quality of rosin, thus produced, has enhanced its usefulness for a number of potential industrial uses. To-day 90% of gum rosin produced in U.S.A. is in the top 3 to 4 grades, while our production of these grades is less than 25%.

INDUSTRY REVOLUTIONIZED

Up to 1930, Indian Naval Stores Industry did very well. Spain and Portugal which now occupy leading positions, had just started. America was still using fire stills and France was the only country with a well developed industry. The demand for rosin and turpentine had increased and Indian products found ready market in foreign countries.

During the period 1930–40, development of industry, in Europe and America, went ahead by large strides and the methods of work were so improved as to produce high grade products at lower cost. This brought about a slump for the Indian industry which gradually lost its markets. The declaration of war in 1939 and the resultant general scarcity of products gave an impetus to the industry again but it was understood by those who knew the subject that the industry had lost its ground and will not be able to hold its own unless the methods of work were set on modern lines. The saying 'Experience has no substitute' was more true of industry than of other walks of life. Success of an enterprise depends entirely on specialized experience and technical skill.

PRESENT CONDITION

Before partition, there were two principal manufacturing concerns in the country, (1) The Jallo Rosin and Turpentine Factory of Lahore and (2) The Indian Turpentine and Rosin Factory of Bareilly (U.P.). In the early years of war, Kashmir Government put up a factory at Miran-Sahib near Jammu.

After partition, Jallo factory went to Pakistan and now there are 3 manufacturing concerns in the country, (1) The Indian Turpentine and Rosin Factory of Bareilly, (2)

Kashmir Rosin and Turpentine Factory, Miran-Sahib and (3) Himachal Rosin and Turpentine Factory, Nahan. Assam Government has recently put up a small unit in their state and P.E.P.S.U. Government is also planning to have a factory in Patiala. Besides, there are a large number of cottage distillers in and around Hoshiarpur who consume about two lac maunds of Rosin of Punjab forests. All these units are at present working in their own way without any sort of co-ordination, direction or control. There is competition among the processors and the usual unhealthy practices are followed to obtain the market.

CO-ORDINATION, DIRECTION AND CONTROL

In the principal pine distilling countries, Naval Stores Industry is controlled by a semi-official organization consisting of representatives of the processors and the Government. This looks after the industry from the collection and distribution of raw material to the disposal of produce including direction of research. In this connection, activities of the French organization – Union Corporative des Resineaux – are highly interesting from our point of view.

CONCLUSION

In view of the present unorganized condition of the industry with 3 factories already working and two in the offing – all under State Government managements – it is highly desirable that the work should be planned and well directed. The writer, is of the view that a semi-official organization, consisting of the representative of processors and state Governments, may be sponsored by the Government of India for the development of the industry. This should plan production and arrange supply of raw material to processors ; all production should be placed at its disposal for distribution in the home market, and export. Each unit may be responsible for its own working but should follow a common policy with regard to packing, quality, prices and marketing of products. Research on derivatives of rosin and turpentine and development of industries involving uses of rosin and turpentine may also be the functions of the organization.

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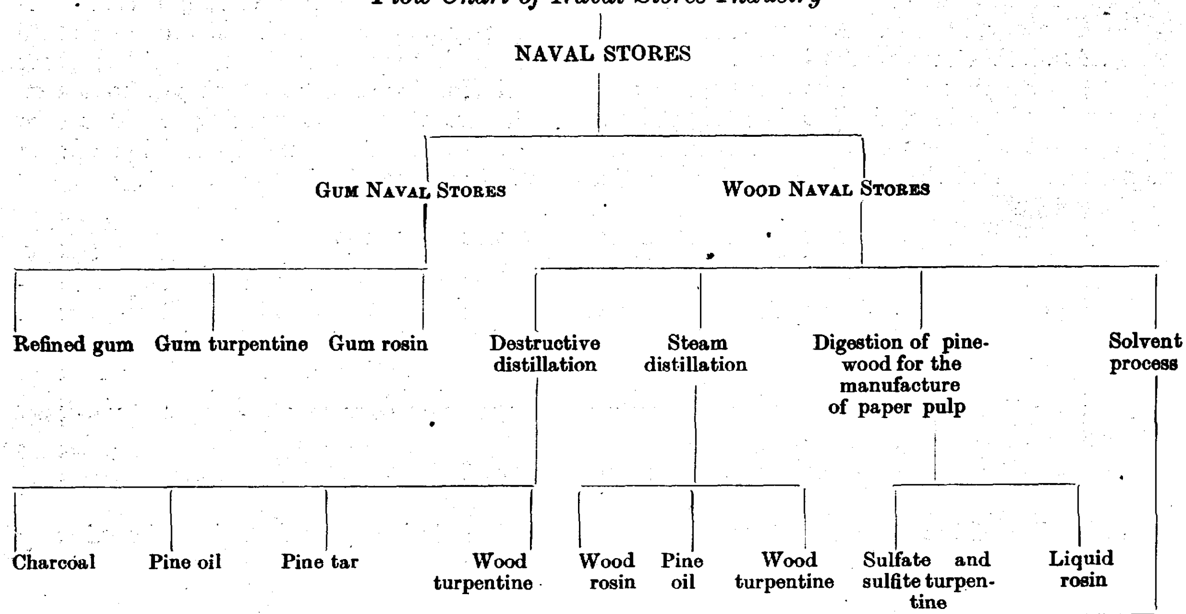
(Flow Chart will be found on next page).

Flow Chart of Naval Stores Industry



The advent of gasoline fractions of narrow boiling range have cut down the use of steam process and the major processors of light wood and stumpage prefer to use straight solvent extraction with benzol, Naphtha and the like. fractionating the resulting solution.

High quality mixed forests of Cheondha F.S. containing *Semal, Bija, Polyalthia* and *Garari*, etc.
(South Chanda Division)
Photo by L. Rai.

Coupe No. IV, Watrana F.S. (Naturally regenerated teak) 11 years old.
(South Chanda Division)
Photo by L. Rai.

Teak seedlings under shade (Natural) Coupe No. VII, Cheondha F.S.
(South Chanda Division)
Photo by L. Rai.

Teak Plantation of 1951. Compartment No. 18, Coupe No. XIII, Cheondha F.S.
(South Chanda Division)

Photo by L. Rai.

Plantation of *Ailanthus excelsa* (1950). Compartment No. 13.
(South Chanda Division)

Photo by L. Rai.

TOUR NOTES – SOUTH CHANDA DIVISION

BY LAKHPAT RAI, I.F.S.

Chief Conservator of Forests, Madhya Pradesh

29–12–1951

DHABA RANGE

Compartment No. 72—Inspected coupes XV, XVI and XVII of Cheondha F.S. with Conservator of Forests, Central Circle (Shri R. N. Datta, I.F.S.), Divisional Forest Officer, South Chanda (Shri S. S. Buit) and Working Plan Officer, South Chanda (Shri G. B. Dashputre). The Forests visited are some of the finest mixed forests in the State usually II to III Madhya Pradesh quality. The common species found are *Bija* (*Pterocarpus marsupium*), *Semal* (*Bombax malabaricum*), *Dhaora* (*Anogeissus latifolia*), *Kari* (*Saccopetalum tomentosum*), *Lahan karai* (*Polyalthia cerasioides*), *Garari* (*Cleistanthus collinus*) and *Kekar* (*Garuga pinnata*). Bamboo is also noticed here and there in the under-storey. An occasional teak tree is noticed in the over-wood at places and also advance growth of teak in patches. The rock is reported to be Kamtee sand-stone and the soil is a deep rich sandy loam. Bamboos here flowered in 1941 and though it is nearly 10 years since then, mature culms have not yet formed. It may be stated, however, that in really well-stocked patches canopy is very dense and bamboos are not able to flourish. In such places there is hardly any grass or weed growth either.

I am visiting these forests after over 25 years and I now find that though the composition of the forests is somewhat similar as before, the large sized trees of *Bija* and *Semal* which were in evidence before, are no longer there. More teak is also noticeable. Some has come up naturally whereas some has been introduced artificially.

The main purpose of my visit to these areas is to see how they can be worked in future. Going through the existing prescriptions of the plan, it is found that the Working Plan laid down a system of selection-cum-improvement fellings-cum-thinnings for the management of these very valuable mixed forests (these forests, at least the ones not yet worked, are a good example of selection forests). In so far as the system is concerned, there would be nothing wrong in following it but the detailed prescriptions unfortunately are very drastic as their implementation, more or less, amounted to carrying out conversion fellings. It is a pity that the then Working Plan Officer could not visualize the results of these prescriptions. It would be a good thing if a Working Plan Officer can fell some small areas under his own prescriptions and see what happens, before they are incorporated in the plan. Some of the older coupes are now looking like young pole crops with some scattered middle sized and a few mature trees. The felling cycle was a short one, viz., 20 years, and it will, therefore, be seen that a serious damage has been done in so far as future yields are concerned. Assuming that the same system continues, in about 4 years' time we shall be called upon to go over coupe No. I again for working. But I fear that there will be very little to take out from coupe No. I. It is very unfortunate that no real attempt was made in the past to mitigate the results of such drastic prescriptions though, I am told that the girth limits fixed for the exploitation of some important species like *Bija*, *Semal* and teak have been increased. As for the future, the system of management may continue but the felling cycle must be increased and so also girth limits prescribed for the exploitation of various important species. More important than this is the proper regulation of the future yield from these species. If we are unable to carry out any systematic enumerations either partially or wholly, it must be laid down as a prescription in the plan that the growing stock of the coupe should be enumerated fully a year in advance of marking in

order to enable the Divisional Forest Officer to see what could be taken out legitimately and what could be left for the future yield. The results of such an enumeration should also be kept on record in the Compartment History files. I am also of the opinion that though suitable areas in these mixed forests can be converted into teak forests, the operation is not a desirable one considered from a long range point of view because the soil will deteriorate very badly as a result of such operations. No doubt this is a very long range view yet it must be kept in mind. It will, however, be advisable if we can succeed in producing mixed forests with teak about 30–40%.

From some of the areas not yet worked in this locality a preservation plot of about 20–25 acres containing the best mixed forest of this tract should be demarcated. A record of this plot should be kept in the prescribed form as also a complete enumeration of the growing stock. Similarly some individual trees of *Bija* of large dimensions may be preserved for life time.

In coupe XVII climbers have been cut and *semal* trees have been sold to be exploited in advance. The regular marking of the coupe has not yet started. The marking in this coupe should be carried out extremely cautiously and on conservative lines.

Coupe XVI—This coupe was sold in 2 parts and is now under working. Part 1 with an area of nearly 225 acres was sold for Rs. 68,500 whereas Part 2 with an area of 175 acres was sold for Rs. 28,100. The total area of 400 acres was, therefore, sold for Rs. 96,600 giving Rs. 241/8/- per acre. In this very coupe an area of about 40 acres containing advance growth of teak was clear-felled and the existing advance growth cut back over 15 years ago and the result is now a magnificent crop of teak poles looking very much like a plantation. Height is about 40 feet and the average girth about 15 inches.

Coupe XV—The workable area of 290 acres was sold for Rs. 69,100. This coupe is a little poorer than coupe No. XVI. The teak patch of coupe No. XVI continues into this coupe as well. Here, however, the growth is somewhat poorer. Height is about 35 feet and the girth about 13 inches.

Wild animals appear to be in plenty as we saw a herd of *chital* as also fresh pug marks of a family of tigers consisting of a tiger, a tigress and a cub as also the pug marks of a bear.

30–12–1951

Compartment 152, Coupe No. XXX, P.B. II Watrana Conversion F.S.—Inspected the above coupe with Conservator of Forests, Central Circle, Divisional Forest Officer, South Chanda and Working Plan Officer, South Chanda. The area of this coupe is 107 acres. It was sold standing in 1946–47 for Rs. 4,000. The underlying rock is metamorphic but the top-soil is black cotton which is somewhat unusual. The forest crop in this coupe is a good mixture of teak and miscellaneous species, almost in the proportion of 30 : 70 in the over-wood but including the advance growth on the ground the proportion may be 50 : 50 which is very good. The quality varies from III to IV A Madhya Pradesh. The problem of regenerating such forests is an easy one. The forest operations consisted of the removal of dead and dying teak trees, thinning the crop in favour of teak, as also opening up of the teak advance growth under inferior species. As this area forms part of P.B. II, I fear the present prescriptions are likely to encroach on the future yield. Under the garb of removing dying trees, any kind of bad teak is likely to be removed and as such this has to be stopped. At the same time the operation of thinnings should not find place in areas allotted to P.B. II. Judging from the quality of the forest in this locality, I feel that the conversion period of 60 years is rather short and I am inclined to believe that a longer period of conversion of 80 years will be more suitable for this forest. There was no inspection note on record regarding this coupe nor was any treatment map filed in the Compartment History file.

On reading the language of the prescriptions of the Working Plan in respect of P.B. II, I found that it was not very clear, whereas the instructions in a Working Plan, more particularly in respect of marking and felling rules, should be couched in an absolutely simple and clear language without any ambiguity what-so-ever.

General—As stated above, the existing crop has a good proportion of teak but it is being noticed that after the main fellings, the young crops which are coming up, consist mainly of pure teak. This is very undesirable. We must encourage the growth of miscellaneous species and the revised working plan must devise ways and means to do this. Parts of this Felling Series are situated near Kanhargaon and consist mostly of mixed forests. It is not understood how the forests round Kanhargaon came to be allotted to this Felling Series. I think they deserve to be excluded and placed in some other Felling Series. I also saw some coupes which were felled in the past 10–12 years and was happy to note that the young crop is coming up very well. The only unfortunate feature is that this pole crop is almost entirely teak.

During the last 25 years this range has considerably been opened up as a result of which the forests have become very very valuable. Several contractors in this range have their own trucks for transporting their timber to Ballarshah. Truck traffic is helpful in the maintenance of forest roads whereas bullock carts are very destructive to the road surface.

The forest road from Kanhargaon to Cheondha ends at Cheondha whereas portions of the main road passing through Watrana Felling Series are within 3–4 miles from Cheondha. It is necessary to connect Cheondha with this main road. This can easily be done and should be done.

Inspected the nursery at Jharan. Here nursery stock of various species is being raised for plantation purposes. It has now been found that Paper Mulberry will not be a success in our forests so it is hardly worth while paying any attention to this species.

Wild game—During the course of the evening outing, saw a pack of wild dogs, some *chital*, and a blue bull.

31–12–1951

Inspected the forests of the southern portion of Dhaba range towards Wamanpalli with the Conservator of Forests, Central Circle, the Divisional Forest Officer, South Chanda division as also the Working Plan Officer, South Chanda division. In the southern portion of this range, bamboos have also flowered over large areas but a little later than 1941 and the clump formation is still in a primary stage. Under the dense shade of the mixed forests, bamboos are not doing very well and if we need bamboo, we have to open the upper canopy to some extent. In some places, teak seedlings under shade were seen for instance in coupe No. VII, Cheondha Felling Series.

Compartment No. 18, Coupe No. XIII, Cheondha F.S.—Here a teak plantation was created in 1951 over an area of 5 acres. The original forest consisted of miscellaneous species varying from II to III quality. Except for the reservation of *semal* trees, all the forest growth was clear-felled. The soil is a rich sandy loam and the teak plants are doing well. The spacing adopted is 6 feet × 6 feet and their height is about 1 foot. The expenses incurred are given below:—

		Rs.
(1)	Spreading debris and burning it ..	118/5/-
(2)	Preparation of the stakes ..	19/4/6
(3)	Staking	34/5/6
(4)	Planting (Crow bar)	72/14/-
(5)	Coir strings for staking, etc. ..	4/9/-

(6)	Cost of stumps (about 6,000)	..	270/- (Rs. 4/8/- per hundred approx.).
(7)	Three weedings—		
	(a) Rs. 27/- (b) Rs. 21/8/- (c) Rs. 8/4/-	..	56/12/-
		TOTAL	576/2/-
	Second year's weeding operations	..	40/- (approx.).
	Third year's weeding operations	..	25/- ,,
	Casualty replacements	..	9/-
		GRAND TOTAL	650/-

or roughly Rs. 130/- per acre.

This in my opinion is rather an expensive work. In particular I consider that the expenditure on items (1) and (4) should have been less.

Compartment No. 13—Some experimental work was carried out in this compartment on raising plantations of softwood species. *Semal* was tried in 1948 and also earlier in various ways but there was no success in the beginning. Some plants have, however, established since then.

Bija stumps were put in 1949, about 40% of which are alive. Some of the plants are really good and healthy. It is not very clear why the other plants have not done so well. In my opinion when this trial plantation was made, stumps of various sizes should have been planted out separately so that we could find out if the size of the stump had anything to do with the subsequent growth. In future such experiments should be carried out after consulting senior officers. Otherwise a lot of time and money is wasted unnecessarily.

Toon (*Cedrela toona*) was also tried but proved to be a failure. *Sewan* (*Gmelina arborea*) has succeeded to some extent but not really well enough. However, the best success has been achieved in the case of *Maharukh* (*Ailanthus excelsa*). In the case of this species, the seed was sown directly in 1950 and the present plantation indicates the growth of 2 seasons. The best plant is 11 feet 6 inches in height and 10 inches in girth at breast height. The average height is, however, about 4 feet 4 inches and the girth is about 6 inches at 1 foot above ground level. There was a defoliator attack in this plot but the plants have survived the attack.

Semal stumps were put in a few rows and also some transplants but there has been a considerable damage from porcupine. The results are not altogether unsatisfactory but they will be clearer in a couple of years' time. Some root cuttings from *semal* trees have also been put in small areas. At some places more than one shoot have come up.

I noticed that here only Karka bamboo was used for fencing purposes. This seems to have proved better than wire fencing.

Another plot where some experiments were carried out in 1951, was seen. Here some *semal* stumps and transplants were put in. 60 to 70% of the plants are healthy. The reason for this is reported to be good rains this year and the plants have green leaves. Some paper mulberry has also been tried in this plot and has succeeded but it looks as if ultimately it will die out due to lack of adequate moisture. In this particular plot *sewan* has also done very well.

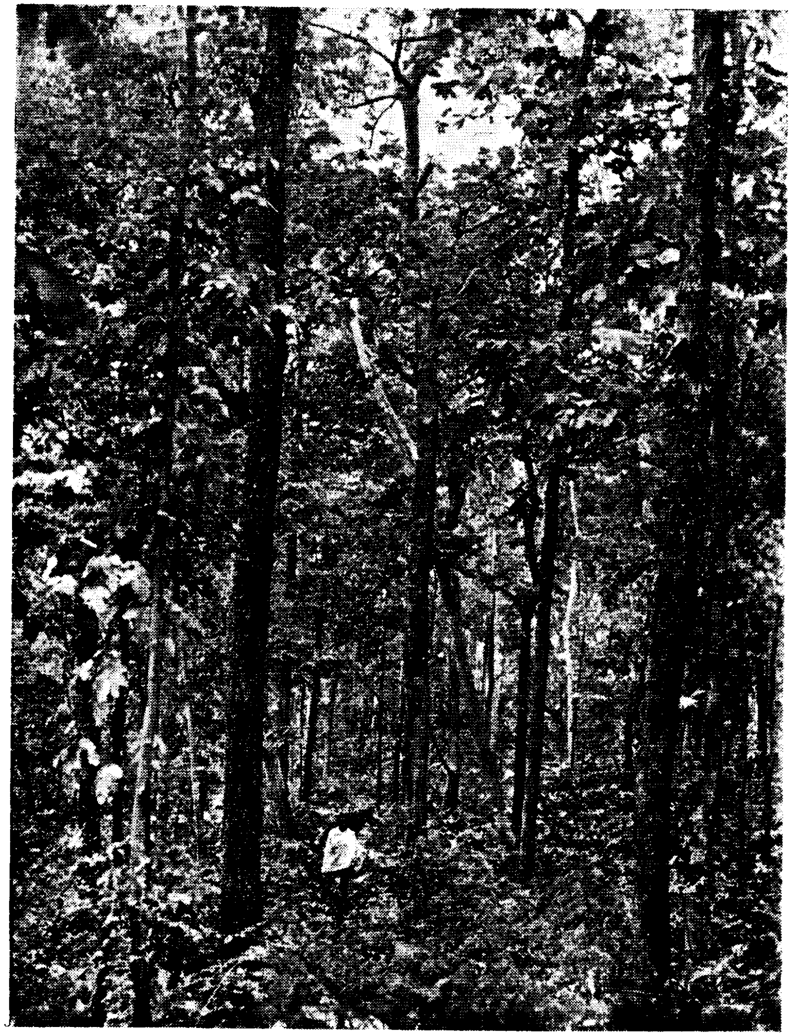


PLATE I. —No filter.

PLATE II. —With filter.

THINNING PRACTICE IN THE ANDAMANS – PAST, PRESENT AND PROPOSED

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SUMMARY

This paper is a review of thinning practice in the Andamans, showing the change-over from sylvicultural crown thinnings to elite thinnings which have been found to be most aptly suited to conditions prevailing in these islands. Elite thinnings have been started only from 1952 and on experience gained through the years, this Forest Department, plans to formulate a thinning practice of its own, based on the elite pattern.

Prior to 1931, the Andamans forests were worked purely with a view to exploitation, little or no regeneration work being done at all. Attempts had been made, but as they were not successful, the staff resorted to artificial regeneration and the creation of plantation. Relicts of these plantations can still be seen to-day. Few of them, however, are really anywhere near success. Besides this, the cost of creating the plantations was found to be far too great and after a short trial, artificial regeneration in the form of plantations was stopped. In the meantime some of the Forest staff kept studying the behaviour of advance growth present in areas under felling and experimented on methods of natural regeneration which were variations of the Shelter Wood Compartment system. These in time proved to be very successful and resulted in prolific regeneration of indigenous species in Baratong Island, Porlob Island, Guitar Island, Kitaung, Kalapahar and Colebrooke in Middle Andamans and Sound, Stewart and Interview Islands in North Andamans. Before the occupation of these Islands by the Japanese almost 16,000 acres were completely regenerated. The oldest of these regenerated areas date back from 1931–32–33–34, whilst the newest areas were regenerated in 1938–39.

I. Two storied forests of the Andamans – 1936 Regeneration Area, Sound Island, North Andamans before thinning.

II. 1936 Regeneration Area, Sound Island – after thinning as proposed in para 11. Note that the two storied nature of the forest is still maintained.

2. As a result of the natural regeneration of these forests, the question of thinnings naturally arose. To control and improve the development of the crop by chosing the correct type and class of thinning was quite a problem, as very little of the silviculture of the individual species was known. Even to-day, very little is still known of the silviculture of the individual species of our forests. There is still plenty of room for experiment in this line. Past records

show that another problem was the question of the mixture to be retained in the eventually thinned crop. Several experiments were, therefore, conducted to solve these difficulties.

3. For a start the thinning cycle was fixed provisionally at 5 years up to the age of 10, with subsequent periods of 10 years. This was only a provisional fixture based on general observation. Further, experiments were carried out in an attempt to make the first and second thinnings mechanical, so as to enable the subordinate staff to carry on the work without much gazetted supervision. The question of thinning being done by the subordinate staff in the Andamans is actually a rather important problem in that the majority of the subordinate staff is untrained. In fact, quite a number of the Rangers themselves have not been trained in any forest school but have graduated through the hard school of experience. It was, therefore, necessary and is still necessary to make thinning as automatic as possible in these islands. Experiments carried out to evolve the required grade of thinnings were purely in the class of silvicultural crown thinnings. Crops were thinned to different spacement and periodic measurements taken of the resultant crop. Records show that on examination of the results of the first thinning it was decided in 1941 that the best intensity is a spacement of 1/3rd height and that before thinning any area it should be classified. The classification as agreed upon then showed three classes. However, these experiments were not final.

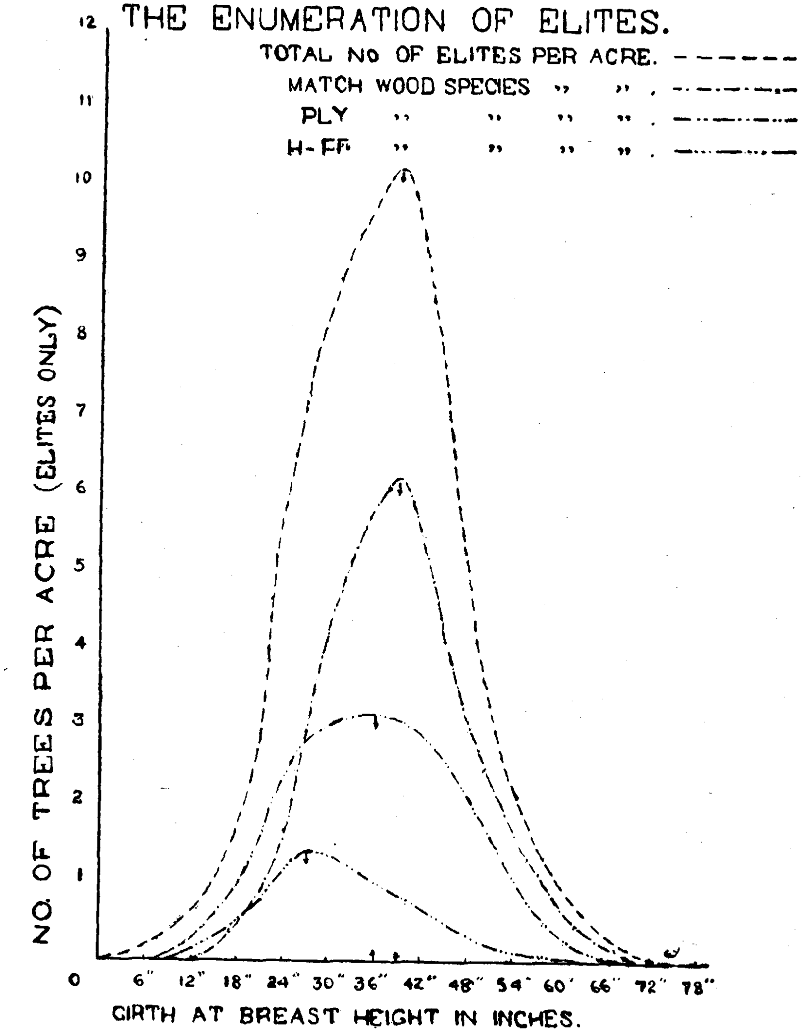
4. Experiments were also carried out on the line of mixtures as it was thought by some that pure crops would be best and easier to manage. Others, however, felt that thinnings should be done to encourage almost all species in the same area. The results of these experiments unfortunately could not be followed up, as the Japanese occupied these islands in 1942 and after reoccupation no further action could be taken on previous lines, because of other pressing problems.

5. Officers from the Silviculture Branch of the Forest Research Institute, Dehra Dun, also visited these islands in pre-war days and marked out some sample plots in the regeneration areas to determine the effect of various grades of thinning. Unfortunately these were never followed up. These experiments of the Forest Research Institute were done both in pure areas, i.e., in plantations and in mixed crops in regeneration areas. At the request of the Forest Research Institute, these plots have been remarked in 1952.

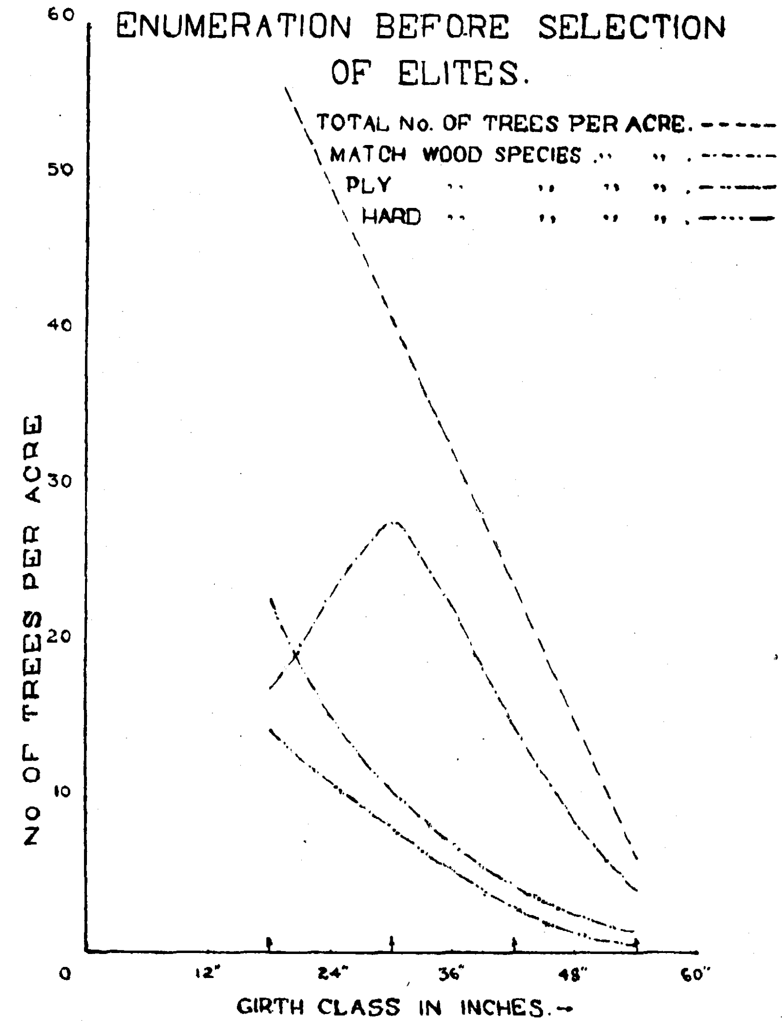
6. From a close study of signs on the ground it appears that thinnings carried out in the regenerated areas, during the pre-war era were more in the nature of cleanings in the crop which after a period of 5 years growth had formed thicket. On enquiry from the subordinates who had been in service in pre-war days it is found that in these thinning operations, or actually speaking cleanings, non-commercial species were removed, as also deformed and suppressed stems of commercial species. No definite spacement, however, was followed in most areas. After the war when the Forest Dept. was reformed and functioning once more, silvicultural operations were once more started in 1946–47. The old regenerated areas were inspected and where necessary, thinnings were carried out. These thinnings were purely silvicultural crown thinnings following textbook pattern as far as possible. The question of grades was taken up again and in Middle Andamans there are several sample plots for the study of thinning grades. No definite conclusions, however, were arrived at as to the correct spacement and the correct mixture to be adopted whilst thinning. These silvicultural thinnings after 1951 were, therefore, still in the experimental stage, each officer thinning according to his own views on the subject.

7. In 1951, these islands were visited by Shri M. D. Chaturvedi, I.F.S., Inspector-General of Forests. He came in the month of October when all timber species were in full leaf, and after visiting several areas in the islands he pointed out the futility of silvicultural thinnings, where vast amounts of money are spent in felling poles and saplings, which are not saleable at all. Elite thinnings were suggested by him and this system of thinning has been

GRAPH ILLUSTRATING THE RESULTS OF THE ENUMERATION OF ELITES.



GRAPH ILLUSTRATING PRELIMINARY ENUMERATION BEFORE SELECTION OF ELITES.



adopted by this department from the year 1952. In this simple and precise method, thinnings are carried out in favour of elite trees which are chosen at the initial stage when the average height of the crop is about 25 feet. Elite trees are chosen and marked to form the future crop, and all thinning is done in favour of these trees. The rest of the crop which lies between these elite trees is not thinned at all but left to natural selection. The advantages of this type of thinning over textbook patterns, as far as the Andamans is concerned are :—

(1) costs are less since less clearing is done ; and

(2) these thinnings can be executed by non-trained subordinates. As pointed out previously trained subordinates are very scarce in these islands.

(1) On the question of cost it must be remembered that in these islands forest labour is not available locally. Labour has to be imported from the mainland. Wages consequently are high. Besides this, there is no market for the yield made up of felled poles and saplings. Whatever is thinned has to be left in the forest as waste. Therefore, the expenditure incurred in intensive cleaning and felling of suppressed and unwanted stems, is not made up in any way by returns obtained by the sale of thinned materials.

(2) Amongst the subordinate staff to-day in the Andamans there are only three trained Rangers. By far the majority of the forest staff is untrained and if at every thinning operation instructions are issued on the line of grades, it would be very difficult to rely on the work executed by these untrained staff. Thinnings should, therefore, be as far as possible mechanical, avoiding to the maximum extent possible any misunderstanding of orders and the destruction of the future crop. Based on these instructions and original suggestions of the Inspector-General of Forests, the Forest Department of the Andamans is now evolving a thinning technique of its own.

8. Since October 1951, thinnings are being done on the elite system, and are strictly confined to provide sufficient growing space only for trees which are likely to constitute the final crop at the end of the rotation. Attention is focussed from the onset only on elite trees whose form and dominance ensure their constituting the final crop at the end of the rotation and, therefore, entitle them to special consideration in the provision of growing space. The Inspector-General of Forests in his Tour Note suggested that the selection of trees for this future crop should be done boldly and as far as possible a spacement of about 45 feet should be retained, even if it meant sacrificing better grown trees. This proposal, however, is not being strictly adhered to as from preliminary experiments carried out in the North Andamans Division it is quite evident that a spacement of 45 feet is far too great indeed. In his Tour Note No. 3, on Interview Island, the Chief Conservator of Forests on an inspection of the thinnings done has pointed out the grave possibility of this operation degenerating into a mere mechanical retention of 20 of the fastest grown species only, while the other generally valuable and desirable species such as our durable hardwoods and *Paduak*, required in the mixture, are left to compete amongst themselves, and in all possibility will form an unthinned, etiolated and stagnant crop.

9. On a close inspection of the virgin forests of the Andamans, it will be seen that there are very definitely two canopies to be dealt with. In the mature crop, i.e., in areas in which extraction is taking place at the moment this difference in the canopy although present is not so clear. On inspecting areas that have been regenerated, however, the two canopies of the crop present themselves very clearly indeed. In deciduous areas the topmost canopy is always occupied by White *chuglam*, *Badam*, *Papita*, White *dhup*, *Didu*, whereas the second canopy consists of *Pyinma*, *Padauk* and several of the durable hardwoods like Red *Bombwe*, etc. Species like *Padauk* and *Pyinma* are often found in both the canopies depending on the area under investigation. *Gurjan* when found in deciduous forests is always in the topmost canopy. In evergreen forests the topmost canopy is always occupied by species

like *Gurjan*, Red *dhup* and *Kadam*, whereas the lower canopy consists of *Tongpeing*, *Lakuch*, etc. Such being the case it naturally follows that when the crop is being thinned, thinning technique should as far as possible, envisage both the canopies and not be for the benefit of the topmost canopy alone, particularly in view of the fact that some of our very valuable species are to be found in the lower canopy. The intrinsic two storied nature of the forest canopy has been pointed out by Chief Conservator of Forests in his Tour Note No. 3 and as thinning in a crop of this nature will certainly need an examination of both the canopies with a view to obtaining optimum distribution of all marketable species in the final crop, the territorial staff was asked to study the crop from this point of view and to prepare a statement showing the availability of species both in the thinned as well as in the unthinned crop. This was done in the 1931 regeneration area of Interview Island in the North Andamans Division, and the data obtained is as in Appendices I and II.

10. In view of the fact that 20 trees per acre was considered to be far too little, and so as to incorporate trees from both canopies in the future crop, 50 elite trees were selected per acre at a spacement of 30 feet. Actually after the elites had been marked, the average number of stems per acre was 46 and the spacement 31 feet. The area actually thinned was 60 acres and the age of the crop at the time of thinning was 21 years. Before carrying out thinnings, climber cutting, and shrub clearing was done in view of the fact that only one climber cutting was done previously in this crop in 1946. While carrying out thinnings the following points were kept in view :

(i) the best available stems at approximately correct spacement were selected as elite ;

(ii) an approximate spacement of 30 feet between the stems was aimed at ;

(iii) regarding distribution of species amongst elites, the proportion aimed at was matchwood species 50%, plywood 35% and hardwood 15% ;

(iv) elites were given a black coal tar ring at breast height (4 feet 6 inches from the ground) for purposes of identification ;

(v) crowns of the elite trees chosen were liberated by the removal of all trees either over-shadowing or causing congestion to the elite crown. These trees were either cut or girdled to form a clear space right around the crown of each selected stem and equal to half the radius of the elite crown ;

(vi) suppressed trees were not removed ; and

(vii) in order to minimize the extent of thinning, trees having a girth of over two feet were girdled. After marking all the elites an enumeration was done classifying them into 6 inches girth class and the results obtained were as in Appendices III and IV.

11. From the enumeration result it was found that the actual distribution obtained was matchwood 50% of the total crop, plywoods 35%, hardwoods 12% and ornamental wood 3%. The graph illustrating the results of enumeration of the elites, however, shows that the trees selected were of all girth classes as present in the original unthinned crop. On a study of the graph illustrating the preliminary enumeration carried out before selection of elites, the average girth of the crop is 30 inches girth for matchwood and 18 inches girth for plywoods and hardwoods. The elites should, therefore, have been chosen among trees approximately of this girth and not too far removed from it because the object of management is to have ultimate a crop that is even aged. Trees as shown in the graph with bigger girths than the normal are probably wolves or advance growth and those below the normal are stems which have regenerated at a later stage. The territorial staff were, therefore, advised to keep this point in view and in future aim to keep the elites selected as close to the normal as possible. The practice that is now being adopted, therefore, is that before any thinning operation is

undertaken in an area, sampling is done and a graph prepared illustrating the results of preliminary enumerations. After a study of the graph the normal is then taken and when elites are selected in the field, stems as close to the normal as possible, without disturbing the planned spacement of 30 feet, will be selected. As a result of this instruction when thinning in the 34 acres of the 1936 regeneration area in Sound Island, North Andamans, elites were selected as close to the normal as possible and the elites obtained in various girth classes were as in Appendix V. From the figures obtained, the density of the ultimate crop per acre is 25 trees of the first rotation, i.e., matchlogs and White *chuglam* and 24 trees of the second rotation. Besides, the proportion of species present on the ground is :—Matchlogs 37%, Plylogs 25%, Hardwood 4% and Ornamental woods 34%. This is as desired, as there is a scarcity of Ply and Match because of the preponderance of *Padauk*, which is our most valuable species. There will also be no difficulty in future extraction, as *Padauk* is a self floater and can be rafted by itself.

12. As will be seen from what has been written above, elite thinnings have only just been started in the Andamans and as such are still in the experimental stage. Experiments so far carried out have been mainly in deciduous forests but from general observation it is expected that they will also be successful in evergreen forests. As suggested by the Inspector-General of Forests in his Tour Note, areas thinned will be inspected after a period of 5 years and any further modifications required will be attended to.

13. What, however, is important is that the cost of thinning has been definitely reduced, and the wasteful practice of thinning in favour of stems that might later be removed by the thinning officers of the future, has been done away with. A definite improvement that has been achieved is in the way of costs. In the Silvicultural thinnings carried out in the past, the cost of thinning per acre has always been in the region of Rs. 12/- to 15/-. The actual minimum cost incurred per acre has been Rs. 12/- and more often than not the cost of thinning has been in the neighbourhood of Rs. 15/-. With the present system of elite thinnings the cost has been reduced for the actual thinning operation to only Rs. 5/- per acre.

14. Preliminary thinning practice in experiments conducted in North Andamans had been to clear the undergrowth before thinning, but this has been stopped by the Chief Conservator of Forests. In his Inspection Note No. 3 he ordered that this practice of cutting the undergrowth be stopped in view of the additional expenditure incurred. As stated in Chief Conservator of Forests's Inspection Note, it is true that even in regeneration areas on the Indian mainland a certain amount of undergrowth is always present, but sometimes the undergrowth in the Andamans is extremely dense and impenetrable, which slows down the rate of progress of thinning, and consequently increases the cost. In such cases it may be desirable to cut the undergrowth before the first elite thinning.

15. Experiments were later carried out in Sound Island where guide lines were cut and later on thinnings were done. The cost incurred in this operation was Rs. 7/8/- per acre line cutting, Rs. 6/8/- per acre for thinning. This in comparison with the previous practice of cutting undergrowth before thinning has actually involved slightly more expenditure in that actual elite thinnings in Sound Island cost only Rs. 5/- per acre when they are carried out after cutting of brushwood which cost in the same area Rs. 7/- an acre.

16. A last suggestion put forward for future practice is that all shrubs and trees under an elite and not interfering with its crown development or causing congestion should be felled and removed because these are the supports on which climbers and lianes initially grow and eventually reach the elite tree which they will certainly damage. Herbs and grasses and low shrubs if left to protect the soil from the drip of the elite as it grows higher and higher should suffice. This little clearing will involve hardly any additional expenditure, but will achieve additional advantages, in removing supports for climbers and lianes and also providing clear space for the natural regeneration of the elite species.

APPENDIX I

Enumeration of Interview Island 1931 Regeneration Area before elite Thinnings – Area 20 acres

Serial No.	Species	Girth classes 12″–24″	24″–36″	36″–48″	48″–60″
	Matchwood				
1	White *dhup*	130	339	108	15
2	*Papita*	143	164	134	57
3	*Thitpok*	18	16	4	1
4	*Didu*	25	37	45	4
5	*Lambapathi*	18	..	..	..
6	*Letkok*	1	..	..	..
7	*Shownye*	2	..	..	..
8	*Kadam*	1	..	..	..
	TOTAL	338	556	291	77
	Plywood				
9	*Gurjan*	59	8	4	6
10	*Badam*	181	92	41	12
11	White *chuglam*	221	103	46	11
12	*Lalchini*	2	5	..	..
13	Red *dhup*	..	..	1	2
	TOTAL	463	208	92	31
	Hardwood				
14	Black *chuglam*	51	6	3	..
15	*Pyinma*	70	88	26	4
16	*Toungpeing*	21	20	9	3
17	*Posa*	100	69	10	1
18	*Ywegi*	5	..	3	..
19	*Jungli neem*	..	1	..	..
20	*Lakuch*	14	1	..	..
21	*Koko*	8	6	4	1
22	Hill *mohwa*	1	1	1	..
23	*Ailanthus*	3	5	..	1
24	*Jhingan*	8	2	..	..
25	*Lal bombwe*	4	1	..	..
	TOTAL	285	200	56	10
	Ornamental wood				
26	*Padauk*	56	18	7	4
	GRAND TOTAL	1,142	982	446	122

APPENDIX II

Summary

Category	12″–24″		24″–36″		36″–48″		48″–60″		Total		Percentage
	No. of trees	Trees per acre	No. of trees	Trees per acre	No. of trees	Trees per acre	No. of trees	Trees per acre	No. of trees	Trees per acre	
1. Matchwood ..	338	16·90	556	27·80	291	14·55	77	3·85	1,262	63·10	47%
2. Plywood ..	463	23·15	208	10·40	92	4·60	31	1·55	794	39·70	28%
3. Hardwood ..	285	14·25	200	10·00	56	2·80	10	0·50	551	27·55	21%
4. Ornamental wood ..	56	2·80	18	0·90	7	0·35	4	0·20	85	4·25	3%
TOTAL ..	1,142	57·10	982	49·10	446	22·30	122	6·10	2,692	134·60	

APPENDIX III

Enumeration Figures of elite Trees marked in 1931 Regeneration Area – Area – 60 acres

Serial No.	Species	12″–18″ No. of trees	18″–24″ No. of trees	24″–30″ No. of trees	30″–36″ No. of trees	36″–42″ No. of trees	42″–48″ No. of trees	48″–54″ No. of trees	54″–60″ No. of trees	60″–66″ No. of trees	66″–72″ No. of trees	72″–78″ No. of trees	Total No. of trees
1	White *dhup*	..	16	109	176	217	97	41	7	..	..	..	663
2	*Papita*	2	9	54	74	122	119	94	33	25	6	2	540
3	*Didu*	1	2	10	15	23	24	9	4	2	..	..	90
4	*Thitpok*	1	2	4	12	6	6	2	2	1	..	..	36
5	*Lambapathi*	2	8	10	4	9	2	..	..	..	..	..	35
6	*Letkok*	3	6	2	3	1	1	..	..	..	..	..	16
7	*Badam*	14	39	96	89	107	79	54	18	2	..	..	498
8	White *chuglam* ..	15	35	80	85	76	80	43	15	6	3	2	460
9	*Gurjan*	1	4	8	3	5	1	..	..	..	..	..	24
10	*Pyinma*	4	7	27	42	32	18	4	..	..	..	..	134
11	Black *chuglam* ..	13	33	33	14	5	6	1	2	..	..	..	107
12	*Toungpeing*	..	1	14	8	10	8	4	1	..	..	..	46
13	*Koko*	3	5	5	2	2	4	1	2	1	..	..	25
14	*Jungli neem*	..	..	1	4	3	..	1	..	..	..	..	9
15	*Lakuch*	..	..	4	1	..	..	..	..	..	..	..	5
16	*Posa*	..	1	2	..	..	1	1	..	..	..	..	5
17	*Ywegi*	..	1	..	..	..	1	..	..	..	..	..	2
18	Red *bombwe*	..	..	1	..	..	..	..	..	..	..	..	1
19	*Padauk*	3	4	14	15	20	9	10	4	1	..	..	80
	TOTAL	62	193	474	547	638	456	265	90	38	9	4	2,776

APPENDIX IV

Summary

Category	12″–18″	18″–24″	24″–30″	30″–36″	36″–42″	42″–48″	48″–54″	54″–60″	60″–66″	66″–72″	72″–78″	Total No. of trees
1. Matchwood ..	9	43	189	284	378	249	146	46	28	6	2	1,380
2. Plywood ..	30	98	184	177	188	160	97	35	8	3	2	982
3. Hardwood ..	20	48	87	71	52	38	12	5	1	..	..	334
4. *Padauk* ..	3	4	14	14	20	9	10	4	1	..	..	80
TOTAL ..	62	193	474	547	638	456	265	90	38	9	4	2,776

APPENDIX V

Analysis of elites marked in 34 acres in 1936 Regeneration Area, Sound Island

Serial No.	Species	Girth classes				Total	Average per acre
		0–1′	1–2′	2–3′	3–4′		
1	*Papita*	..	101	245	130	476	14
2	White *dhup*	..	26	36	1	63	2
3	*Didu*	..	37	24	10	71	2
4	White *chuglam*	..	77	96	52	225	7
5	*Badam*	..	54	77	37	168	5
6	*Padauk*	141	254	185	..	580	17
7	*Pyinma*	..	13	6	..	19	·5
8	Black *chuglam*	..	6	4	..	10	..
9	*Koko*	..	8	7	..	15	·5
10	*Lakuch*	..	13	6	..	19	·5
11	*Nabbe*	..	4	..	..	4	..
12	*Ywegi*	..	9	5	..	14	·5
	TOTAL	141	602	691	230	1,664	49

Number of trees in the first rotation per acre (item 1 to 4) 25

Number of trees in the second rotation 24

PROTECTION OF FORESTS OF INDIA FROM ANIMALS*

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SUMMARY

Some animals cause mechanical damage, some by browsing, some by stripping the barks of trees, some by destroying seeds, seedlings and roots, while some cause damage by grazing. Elephants, rhinoceros, bison and pigs cause mechanical damage to the forests. The first two by damaging the fences erected in forests, facilitate the entrance of other animals into the protected area. Bison also does a similar damage, but pigs cause considerable harm by uprooting seedlings, coppice shoots and seedlings. Trenches have been dug in the forest for affording protection against elephants and pigs. In some places stone walls have also been erected for protection against the latter. Fences and crude country bombs have also been tried against the pigs.

Elephants, bisons, *sambur* and black bears are guilty of stripping the barks of trees. Elephants have a partiality for the bark of the *Artocarpus integrifolia*, while bison strip the bark of *Acrocarpus fraxinifolius*. *Sambur* peels off the bark of *Chukrasia* in addition. Black bears, strip the bark of many deodar, spruce and *kail* poles to lick the rising sap and the cambium layer. Elephants, bison, *sambur*, *nilgai* and members of the deer family, goats and sheep are guilty of browsing many forest species.

While there is no direct remedy against damage by elephants and bisons, the other soft skinned game are kept out by game proof fencing. Live hedges are also tried. As camels, goats and sheep are domestic animals the remedy is to prohibit them from entering the forest. Hares and rats cause considerable destruction of seeds and seedlings and roots. Their damage can be minimized either by using poisoned baits or by cyanogassing them or by using wire nets.

Grazing probably does more injury to the forest than even fire. The damage done by semi-wild cattle is kept down by capturing and selling them. In some places *kheddah* operations are also conducted to capture them. To minimize the damage done to the forest by the ordinary grazing cattle is rather difficult as it is closely bound with socio-political considerations. So long as regulation of grazing cannot be enforced, damage from excessive grazing by the domestic cattle cannot be minimized.

The damage caused to the forests of India by animals are varied. Some animals cause mechanical damage, some by browsing some by stripping the barks of trees; some by destroying seeds, seedlings and roots ; while some cause damage by grazing. The nature and extent of damage caused by these animals and the measure taken to counter these, are described in this paper.

MECHANICAL DAMAGE

ELEPHANTS by damaging the fencing erected in forests facilitate the entrance of other animals into the protected area. They also damage mechanically teak plantations in Malabar and in Coimbatore. As a protection, elephant proof trenches are sometimes dug, but they do not find wide application on account of their cost and the hard and rocky soil conditions met with in the elephant country. As a measure of precaution regeneration areas are not located in places which are habitually haunted by elephants or lie across frequented elephant tracks,

* Paper presented to the Commonwealth Forestry Conference, Ottawa, Canada, 1952, under the caption "Protection - Biological - Animals - India".

saltlicks, grazing grounds and water sources. Likewise, areas containing good growth of bamboo are avoided and species liked by elephants are rarely planted. As an indirect measure to minimize damage from elephants, they are captured either by the pit method or by *kheddah* operations. A few well dispersed pits intended for capturing the elephants, have saved many teak plantations from ruin. In some states like Orissa, U.P., and Bihar destruction of elephants by shooting is being advocated.

In portions of Bengal and Assam RHINOCEROS causes some mechanical damage by walking along regeneration lines, knocking down fences. But the damage is not serious enough to warrant counter measures. BISON does a certain amount of mechanical damage to young trees and regeneration throughout the country. PIGS do considerable mechanical damage by uprooting seedlings and damaging coppice shoots and seedlings. In Wynaad (Malabar district) to the writer's knowledge, an experimental teak plantation, about 20 acres in extent, was completely wiped out, all the stumps being completely uprooted. As a protection pig proof ditches 4 feet deep and two feet broad at the top but narrowing down, or stone walls four feet hight, two feet wide at the bottom and one foot wide at the top are made. Wove wire fencing $9\frac{1}{4}$ gauge 48 inches high with the lowest strand below the ground level have also proved effective. Night watchmen, rough scare crows, crude country bombs covered with flesh have been tried, but with indifferent success. Where damage from pigs, is great pig drives are also organized.

BARK STRIPPING

In Malabar district, ELEPHANTS have specially stripped the bark of every Jack (*Artocarpus integrifolia*) tree in the forest plantations. BISON is known to strip the bark of young *Acrocarpus fraxinifolius*, while SAMBUR peels off the bark of *Chukrasia* in addition. Throughout India, *chital* and *sambur* damage the bark and cambium of saplings of poles of a variety of species by rubbing on them their antlers while in velvet. BLACK BEARS damage many deodar (*Cedrus deodara*), spruce, *kail* (*Pinus excelsa*) poles by stripping of their bark at the base to lick the rising sap and the cambium layer. They are also responsible for girdling many trees. In Kashmir they are permitted to be shot.

BROWSING

Forests suffer very much from browsing especially areas under regeneration ; elephants, bison, *sambur*, *nilgai* and members of the deer family, goats and sheep are all guilty of this.

ELEPHANTS feed on the branches of *Morus laevigata* and *Artocarpus chaplasha*. They even break down large trees of these species in order to eat their branches. Elephants have a special fondness for bamboos. The mature culms are broken and shoots of the year are destroyed thereby weakening the clumps, which thence forward can put up only under developed or stunted annual culms with diminitive leaves or form bushy outgrowths with whippy branches.

BISONS repeatedly browse on the seedlings of *Artocarpus hirsuta*, as also those of *Dalbergia latifolia*, *Pterocarpus marsupium* and *Hopea*. These were such a menace to the "gap" regeneration areas of evergreen forests that the operations had to be abandoned.

Sambur, *nilgai*, and members of the deer family also cause considerable damage by browsing. In Assam, the deer browse on *Morus laevigata* and *Artocarpus chaplasha*. In Bengal also similar damage has been reported. As a protection the areas are fenced. *Sambur* and deer have a partiality for the leaves and tender shoots of *Chloroxylon swietenia*, young sandal, *Dalbergia latifolia*, *Pterocarpus marsupium*, *Albizzia lebbek* and *Hopea*. In Gorakhpur, *nilgai* has damaged the *taungya* plantations of sal and other species. In Andamans, the spotted deer is fast becoming a pest. Protection from the soft skinned game is obtained only by game proof fencing, which consists of wove wire fence and additional strands of barbed wire. Without this

fencing, sal regeneration cannot be obtained in U.P., and in Bengal, as the seedlings are repeatedly browsed down, as soon as they show their heads above the level of surrounding vegetation. Even fences as high as 7 feet 6 inches are cleared by *Sambur*. In Madras when two parallel fences 10 to 12 feet apart were fixed, effective protection against *Sambur* was obtained. Experiments were conducted in Madras in forming live hedges and the following species were found suitable : *Acacia planifrons, Euphorbia* sp., *Prosopis juliflora* and *Protium caudatum*. In *rab* patches, *Cassia siamea* surrounds were found to give sufficient protection from browsing to the species raised inside them. Some states have advocated the shooting of the offending animals in the localities where they are interfering with forest growth. In a way the present state of affairs is due to the policy adopted in the matter of shooting of game animals. At present as only the *Carnivora* and the males of the *Herbivorae* are shot, the natural balance is upset and the soft skinned game multiply enormously. A more rational administration of game rules is indicated to keep down damage done by soft skinned game to forest growth.

CAMELS browse on most of the submontane species in some of the forests of Saharanpur division where they are engaged on Bhabar grass collection work. In Rajasthan they browse on even the little vegetation, which exists in the locality.

Last but not least are the GOATS and SHEEP. Every forest officer knows that where goats and sheep are allowed to browse, such areas cannot be utilized for the production of trees and wood. In protective forests sheep and goats have no place at all. That is what history tells us. Goats are responsible for the destruction of the tree growth wherever it may occur. Only in some reserved forests it has been found possible to exclude them, but still there are many other lands at the disposal of Government where they can graze and browse. Thus the goats play a large part in creating problems of soil erosion and what is worse they play an equally large part in rendering inffective the soil conservation measures which involve raising of plants. India has the doubtful distinction of possessing 27% of the world's goat population.

DESTRUCTION OF SEEDS AND SEEDLINGS AND ROOTS

HARES eat tender succulent shoots of plants as also germinating seeds. Sandal seedlings in Madras are mostly destroyed by hares. According to some, piles of whitewashed stones frighten away hares on a moonlight night. Early burning makes the hares flee from those areas and they never return. PORCUPINES gnaw the roots of *semul* (*Bombax malabaricum*) and other species having fleshy roots. In the *taungyas* of Saharanpur and in the plantations of Dehra Dun, they damage the tree seedlings heavily. In Bengal porcupine damages sal plantations by digging up or burrowing under and feeding on roots. In Madras porcupines in addition to damaging regeneration also consume large quantities of seeds and fruits of the shola trees. Protection from porcupine is achieved by fencing, which is a wire netting 18 gauge 1 inch mesh 4 feet wide, fixed vertically, with 1½ feet below ground and 2½ feet above ground, well staked or otherwise supported by tying to deer proof fencing. Potatoes poisoned with white arsenic are used for killing porcupine in Saharanpur division. In Etawah afforestation division, cyanogassing porcupine in their burrows was first introduced. With 25 lb. of dust and one pump, about 150 porcupine holes were treated and in not even a single case were procupines able to get out alive. In one case where a large burrow was treated no less than fifteen porcupines were counted a few days later, when the jackals had dug in and brought them out. Other methods used for protection against porcupine are (1) using Strychnine or Salted boards ; (2) painting tree with a solution of lead arsenate, and (3) smearing trees with lime and tar.

RATS cause damage by eating away seeds of trees and bamboos. To minimize the damage, baits made of *Barium carbonate* are used. In Kashmir the rat holes are effectively smoked with pine needle smoke and killed. Powdered glass baits are also used successfully against rats. Cyanogassing is reported to be not so effective against rats, as rat holes are

plugged with earth at intervals. A handful of carbide put in a rat hole followed by a gallon of water is an effective way of clearing out rats. Keeping the area free from weeds tends to reduce the intensity of rat damage. Systematic poisoning of rats is done when the field crops in the *taungyas* are harvested. The following are the methods adopted to minimize rat damage :

(*a*) small whitewashed cairns suitably dispersed ;

(*b*) a few stones painted with tar, round the seedlings to be protected ;

(*c*) early burning ;

(*d*) avoiding excessive final weeding at the end of rains ;

(*e*) application of diluted phenyle to the base of seedlings to keep away rats and also hares ;

(*f*) using Strychnine in the form of sugary syrup as a poison to kill the rats ;

(*g*) using baits of sun flower seeds, soaked in Thalium sulphate solution ;

(*h*) wire netting buried in the ground 18 inches deep and turned outwards at the bottom ;

(*i*) cyanogassing ;

(*j*) using wire mesh tubes to protect seedlings ; and

(*k*) avoiding indiscriminate destruction of snakes, which keep down the rat population.

MONKEYS also pull out seeds and seedlings. They eat the buds and young shoots of *Artocarpus chaplasha* plants. Throughout India they eat or destroy large quantities of various kinds of seeds, fruits, etc. Monkeys are not usually killed, but frightened.

GRAZING

Damage to forests by grazing may be caused either by semi-wild cattle or by the domestic cattle. Domestic cattle which have either strayed into the forest or let loose there intentionally when they become dry, acquire wild habits and cause considerable damage to forest growth. Such cattle have become a menace in certain parts of Madras, Madhya Pradesh and Uttar Pradesh. In the olden days rewards were given for shooting these semi-wild cattle, but the system had to be abandoned as it aroused public wrath. Now they are captured and sold depending on the enthusiasm of the personnel, but these spasmodic efforts are not making any impression. In Madhya Pradesh *kheddah* operations were conducted to capture these wild cattle ; also beats were organized.

DAMAGE TO FORESTS BY GRAZING CATTLE

Grazing probably does more injury to the forests than even fire, but this is not generally recognized as the effects are not apparent to the eye of the layman. It includes damage by trampling and browsing both of which are positively injurious to regeneration. In Kashmir, on account of excessive unrestricted grazing, steep slopes of the hills up to 6,000 feet, or more in elevation have been completely denuded of tree growth and this has been replaced in may places by an open scrub growth interspersed with incipient landslips. All this destruction only increases the pressure on reserved forests and in great many places it is a continuous struggle to maintain the forest crop. At the same time excessive grazing is responsible to a large extent for the lack of regeneration in certain forests of Kashmir.

It has been estimated that only five per cent of the total cattle population of India resorts to forest grazing. Even this, according to the 1935 census comes to 295,280,000 heads of cattle. In governmental reserves grazing is either practically free or only a token fee is levied. In general, grazing is not uniformly distributed inside the forest. Accessible areas are overgrazed. On account of repeated grazing, and burning, the stronger and hardier grasses have replaced the tenderer and the more desirable grasses, for fodder. The nutritive value of the existing grasses in the forest is very low and the constant walking in search of food involves an enormous strain on the cattle.

The incidence of grazing is the heaviest on the coniferous and the deciduous forests of India. As such grazing is unlimited and heavy, many deleterious effects have been observed. The soil becomes compact and hardened by the constant trampling of cattle especially on the heavier soils of the plains. Denudation or erosion is accelerated on the lighter soils of the hills where the constant tread of the cattle breaks the soil loose, only to be washed away in the following rains. Most of the serious erosions, denudations and landslips which accur in the Siwaliks and other forest localities similarly situated, may be traced to such excessive grazing. As already mentioned, unregulated and heavy grazing brings about a succession of worthless grasses and thorny species, in place of soft grasses and valuable species. Grazing is naturally most injurious to small regeneration because of the browsing of the tender shoots or buds. Even species distasteful to the cattle may be trampled over and destroyed. Heavy grazing compacts the surface soil and makes it quite unsuitable as a seed bed. Further, grazing is responsible for many forest fires; (1) due to a mistaken notion that burning improves the quality of the fodder grass; and (2) to get the new flush of grass early in the season. Observations made throughout India confirm the world experience that increased incidence of grazing means increased deterioration of the grazing and the forest stand. All the available fodder is rapidly consumed. The forage crop becomes weakened and its quantity is appreciably reduced. Little or no seed is produced, reproduction is prevented and there is a general decline in the carrying capacity of the area. At the same time the tree growth also suffers.

Throughout India accessible forests, have been destroyed by grazing. The demand of the public is insistent and any government will not normally ignore it. All that has been achieved so far, is to close to grazing, forest areas which are under regeneration. Goat browsing has been officially stopped in many States. Regulation of grazing regarding the number and season is in force in some States but in the majority of the States the forest department cannot regulate the grazing at all. Areas which have been repeatedly burnt either accidentally or intentionally, may be closed to grazing under certain conditions. The forest administration has to recognize that grazing is a necessary evil which has to be put up with, especially on the peripheral forest and all that it can do in the circumstances is to take steps to mitigate the baneful effects thereof. This it is no doubt doing, carrying the public opinion with it wherever it is possible. Regulated grazing is good for the forest in that it will not only keep down weed growth, but improve its pasture value in many respects. But such regulation is not possible in the present state of public opinion in many parts of the country. Where progressive elements occur, improved methods of grazing and artificial regeneration of palatable grasses have been introduced, but still one cannot get away from the fact that in Indian forestry, grazing is still a bad master and not a good servant.

THE CORRECT NAME OF INDIAN BABUL

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Babul is a moderate-sized, spiny, evergreen tree with a dark brown or black longitudinally fissured bark and paired sharp-pointed, straight spines ; the flowers are sweet-scented. It is probably indigenous in Sind, Gujerat, Rajasthan and the Deccan and has got naturalized in most parts of India. It is not so abundant in the south and is rare in the extreme north-west on account of its susceptibility to severe frost. It occurs in Ceylon and has been introduced into the dry zone of Upper Burma. It is found also in Arabia, Egypt and Tropical Africa.

The tree varies greatly in size. In some places it is little more than a shrub and in others a fairly large tree. Its growth at different places presents much variation as regards its habit and the nature of its pods. This has resulted in the splitting up of the species into several varieties and sub-species. In India there are three well recognized varieties, viz., (1) the *Telia babul* – a moderate-sized tree with a short trunk, a spreading crown and feathery foliage, considered to be of great economic importance, (2) *Kauria babul* (var. *vediana* Cooke) – a smaller tree with a shorter bole, considered fit for firewood only, (3) *Ramkanta or Ramkati babul* (var. *cupressiformis* Stewart) – conspicuous on account of its broom-like ascending branches. According to Dalziel – "The useful plants of West Tropical Africa" p. 203 (1937) – several varieties, differing in the amount of constriction between the seeds and the degree of pubescence of the pods, have sometimes been regarded as distinct species, e.g., *A. arabica* var. *tomentosa* Benth., has downy pods even when mature ; *A. arabica* var. *adansonii* G. & P. (= *A. scorpioides* var. *adstringens* A. Chev.), with pods scarcely constricted and varying from slightly pubescent to nearly glabrous. Both these have been regarded as deserving separate specific rank but intermediate forms are known, especially where the tree is cultivated. A. Chevalier "Bull. Soc. Bot. France" 1927, 74, pp. 954–55 (1928) distinguishes the following three varieties : (1) var. *pubescens* Benth. – pods pubescent even in the adult stage and strongly constricted between the seeds (2) var. *nilotica* Benth. – pods absolutely glabrous, strongly constricted between the seeds and (3) var. *adstringens* Benth. – pods hairy to almost glabrous, not constricted between the seeds. He has further pointed out that few species are as variable as this one. This is because the plant is frequently cultivated as much in Africa as in tropical Asia. It is the pod of the plant which is chiefly variable.

Of late there has been some disagreement on the question of the correct nomenclature of our Indian babul. Burkill – "A Dictionary of the Economic Products of the Malay Peninsula" I, p. 14 (1935) says "though some botanists regard the African tree with these rich pods which are there employed by tanners, as *A. arabica* others assign it to *A. scorpioides* L., for it differs from the true plant in more than the amount of tannin in its pods". Cowen – "Flowering trees and shrubs of India", p. 62 (1950), suggests that either of the two names, mentioned above, is applicable for babul. Although the name *Acacia arabica* Willd. is acceptable to a larger section of botanists, there are others, who would adopt the new nomenclative combination proposed by A. Chevalier in "Bull. Soc. Bot. France" 1927, 74, p. 954 (1928). The adoption of the name *Acacia scorpioides* (L.) Chev. for the Indian babul, in a recent publication by Dastur – "Useful plants of India and Pakistan", p. 7 has created an interesting case for investigation.

A. Chevalier – "Bull. Soc. Bot. France", 1927, 74, p. 954 (1928) writes : "Acacia vrai ou Acacia d'Arabie. – Cette espèce est tres répandue sous diverses variétés en Afrique

tropicale et en Asie tropicale. Linné l'a decrite en 1753 sous le nom de *Mimosa scorpioides* et quelques lignes plus loin sous celui de *Mimosa nilotica*. Le premier nom est typifié par la synonymie citéé par Linné : *Acacia aegyptiaca* Hern. et *Acacia vera* Pluk. Ces noms correspondent bien á la plante que l' on nomme habituellement *Acacia arabica* Willd. Suivant les régles de priorité elle doit ainsi être dénommée : *Acacia scorpioides* (L.) comb. nov. = *Acacia arabica* Willd. Spec. IV, 1805. p. 1085 = *Mimosa scorpioides* L. Spec. plant., 1753, p. 521 (Acacia, n°28) = *Mimosa nilotica* L. Spec. plant. 1753, p. 521 (Acacia n°31) = *Acacia vera* Willd., IV, 1805, p.1085 = *Mimosa arabica* Lamk. Encycl., I, 1783, p. 19".

The English rendering of the above is "True Acacia or Acacia of Arabia – This species is very widespread under different varieties in tropical Africa and tropical Asia. Linnaeus had described it in 1753 under the name of *Mimosa scorpioides* and sometime later under the name of *Mimosa nilotica*. The first name is typified by the synonym cited by Linnaeus : *Acacia aegyptiaca* Hern. and *Acacia vera* Pluk. – these names correspond well with the plant, which one usually calls *Acacia arabica* Willd. Following the rules of priority it should, therefore, be called *Acacia scorpioides* (L.) comb. nov. = *A. arabica* Willd. Spec. IV, 1805, p. 1085 = *Mimosa scorpioides* L. Sp. Pl. 1753, p. 521 (Acacia No. 28) = *Mimosa nilotica* L. Sp. Pl. 1753, p. 521 (Acacia No. 31) = *Acacia vera* Willd. IV, 1805, p. 1085 = *Mimosa arabica* Lamk. Encycl. 1, 1783, p. 19".

Chevalier made this new nomenclative combination *A. scorpioides* (L.) Chev. on the assumption that the earliest published description of the specios is that of Linnaeus' *Mimosa scorpioides* Sp. Pl., p. 531, 1753 and on the presumption that *Mimosa scorpioides* L. and *M. arabica* Lamk. are one and the same plant.

The validity of Chevalier's combination was doubted by the authors and, in the absence of pertinent literature and type specimens, the question was referred to Dr. N. L. Bor, Asst. Director, Royal Botanic Gardens, Kew, for opinion. The views of Milne – Redhead and H. K. Airy Shaw, of Kew Herbarium, who had looked into the matter, are as follows : "In an unpublished investigation into the typification of *Mimosa scorpioides* Linn., Dandy and I found that there are three distinct elements comprising the 'species' and that the name is best treated as a *nomen dubium*. There is nothing in the original account of *Mimosa scorpioides* L. to justify its application to *Acacia arabica*, as has been done by Chevalier". – E.M.R.

"It looks, as though, one had best continue to use the name *Acacia arabica* Willd." – H.K.A.S.

We agree with the views of Father H. Santapau, of St. Xavier's College, Bombay, who was also consulted in the matter, that the name *Acacia scorpioides* (L.) Chev., cannot be held valid, as it is a later homonym of an earlier published *Acacia scorpioides* W. F. Wight, in Contrib. U.S. Nat. Herb. 173 (1905). Chevalier's combination is of 1928.

From what has been stated above it is clear that the correct name of our Indian babul should be *Acacia arabica* Willd. Consequently Chevalier's nomenclative combination *Acacia scorpioides* (L.) Chev., for the plant in question, falls through and can not be adopted.

AN INVESTIGATION INTO THINNING CYCLES FOR YOUNG *CHIR* (*PINUS LONGIFOLIA*) AT NEW FOREST, DEHRA DUN

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SUMMARY

The description and results of a thinning cycle investigation that has been in progress since 1936 in young *chir* crops at Dehra Dun are given. The thinning cycles under trial are 4, 8 and 12 years, the intensity in all cases being 'D' grade of ordinary thinnings. The shortest thinning cycle has given maximum diameter increment and largest number of trees in the top diameter classes. Its performance is comparable to that of the 8 years cycle from the view-point of basal area and volume production, while the 12 years cycle has given distinctly poorer results. The treatments have had no influence on height growth and the length of clean bole. The 4 year thinning cycle, therefore, gives maximum diameter increment as well as total volume without impairing the quality of the timber. The thinning periodicity may be increased to 8 years without adversely affecting total volume production. The investigation also indicates that thinning intensities lighter than the ordinary 'D' grade should be avoided for high quality young *chir* crops.

INTRODUCTION

1. In 1936 the Silviculture Branch of the Forest Research Institute started 3 comparative thinning investigations in the Demonstration Area of the New Forest estate to study the different aspects of thinnings in young *chir* crops. Two of these deal with the intensity of thinnings and the third one with the thinning cycle. This short note describes the results and experience gained from the investigation on thinning cycles.

BRIEF DESCRIPTION OF THE PROJECT

2. The object of the investigation was to compare the effects of 4, 8 and 12 year thinning cycles on the development of *chir* crops thinned to the same intensity. Nine replicated plots, each one-tenth of an acre in size, were selected in an evenly stocked *chir* crop and the crop thinned to 'C' grade. They were then divided into three comparable sets on the basis of the number of stems per acre, the basal area per acre and the average height of the 10 tallest stems distributed evenly over each plot. The allotment to treatments, within each set, was made at random. It was prescribed that subsequent thinnings in all cases should be the ordinary 'D' grade thinning as per the standard definition of the term, their intensity being further regulated on the basis of periodic basal area increment between consecutive thinnings. The 4 year cycle plots were to be thinned each time on purely silvicultural considerations and the proportion of basal area removed to the periodic basal area increment determined. The basal areas to be removed in the case of the 8 and 12 year cycle plots were to be calculated as follows. If i_1, i_2 and i_3, respectively, were the basal area increments of the

Figure 1.

PROGRESS OF TOP DIAMETERS DURING THE PERIOD MAY, 1936 TO APRIL, 1952.

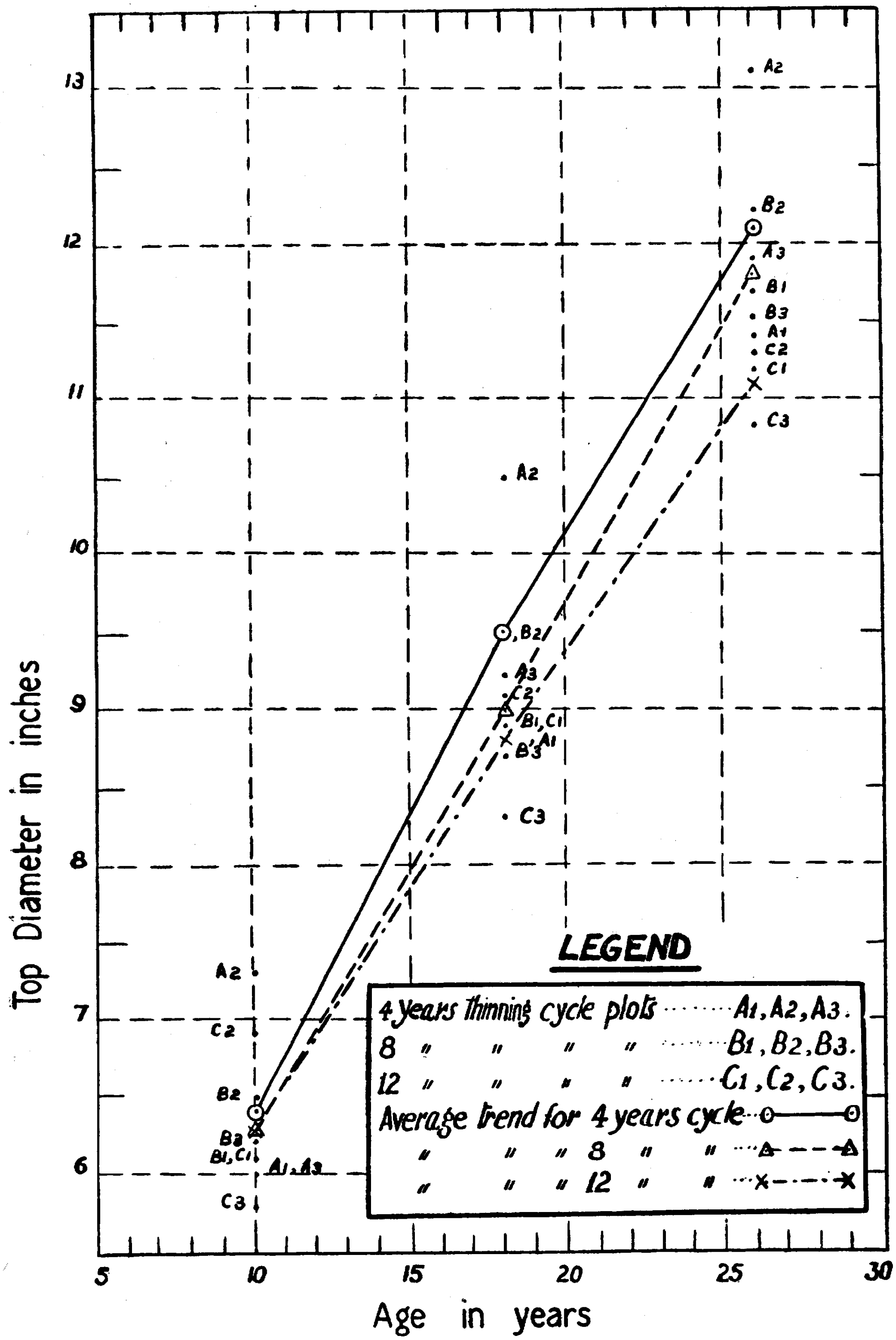
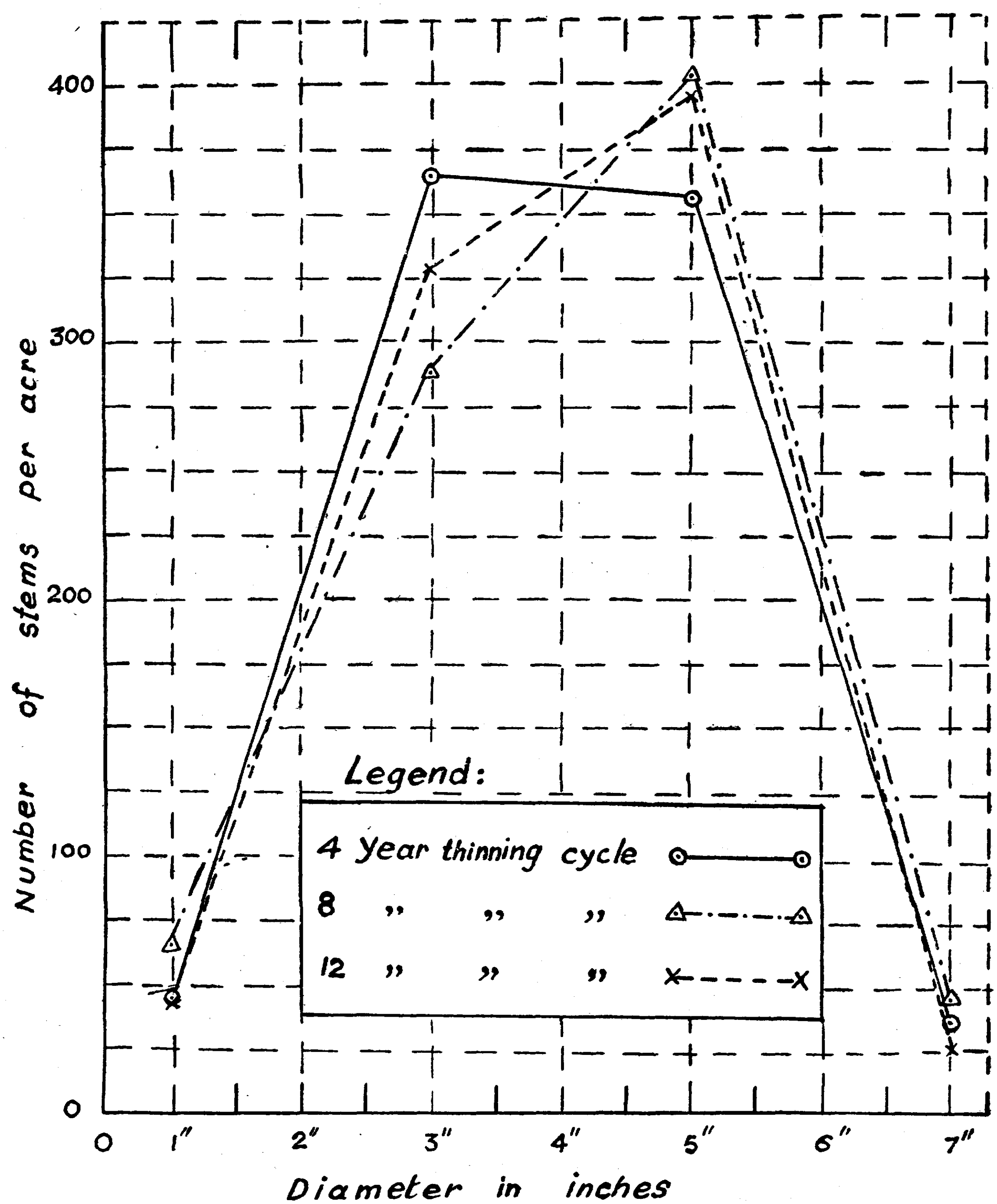


Figure 2.

DISTRIBUTION OF STEMS BY DIAMETER CLASSES
IN MAY, 1936 (AFTER THINNING).



4 year thinning cycle plots for the periods 1936–40, 1940–44 and 1944–48, and a, b, c, the proportions of the basal area increments removed at successive thinnings, and if I_1, I_2 respectively were the basal area increments of any of the 8 and 12 year cycle plots for the periods 1936–44 and 1936–48, the basal areas X and Y to be removed in the longer thinning cycle plots in the years 1944 and 1948 respectively were to be

$$X = \frac{ai_1 + bi_2}{i_1 + i_2} \times I_1 \text{ and } Y = \frac{ai_1 + bi_2 + ci_3}{i_1 + i_2 + i_3} \times I_2$$

The first thinning in all the three cases having been done in 1936, the next simultaneous thinning under the three treatments will be carried out in 1960.

LOCALITY, CLIMATE AND SOIL

3. The plots are situated in compartment 39 of Champion Block of the Forest Research Institute estate. Before being taken over by the Government in 1920 for locating the Institute, this area was agricultural land. The soil is deep clayey loam, with small quantities of leaf litter and humus, overlying conglomerate deposits of unknown depth. The land is practically level, sloping gently to the west and is well drained. Detailed information regarding rainfall and temperature for the locality is given in the following statement. The comparatively light winter rains, coupled with the heavy dew fall received at that time of the year, play an important role and keep the humidity fairly high. The locality presents excellent growth conditions for *chir* pine although the species does not occur naturally in the valley. The quality of the crop on the basis of current Yield Tables for natural *chir* works out to be one full quality class, above the first

TABLE 1.—*Rainfall and Temperature Data for New Forest*

Month	Average* rainfall (inches)	Average† temperature (degrees Fahrenheit)		
		Maximum	Minimum	Mean
January	2·6	64	40	52
February	2·4	70	43	57
March	1·4	80	50	65
April	0·9	90	58	74
May	1·9	99	65	82
June	8·5	96	71	84
July	26·2	90	72	81
August	27·6	84	71	78
September	12·3	85	67	76
October	1·2	83	56	70
November	0·1	75	46	61
December	0·9	69	42	56
For the whole year ..	86·0	82	57	70

* Based on the 15 years period 1931–45.

† Based on the 5 years period 1941–45.

DESCRIPTION OF THE CROP AND CONDITION OF PLOTS AT THE TIME OF FORMATION

4. The *chir* crop in compartment 39 was raised from seeds received from Lansdowne Division in Uttar Pradesh and sown densely in lines 6 feet apart in June, 1926. It was, therefore, 10 years old at the time of starting the investigation, in May, 1936. Light cleanings and thinnings were done in January, 1932, and February, 1935. A final ordinary 'C' grade thinning was carried out in February, 1936 before laying out the sample plots. The condition of the crop in each plot after this thinning is given in Table 2.

TABLE 2.—*Condition of various Plots in March, 1936 after a 'C' grade thinning*

Plot No.	Set No.	Basal area per acre (square feet)	No. of stems per acre	Top height (ft.)	Thinning cycle allotted
43	I	81·8	810	27	4 years
44	I	85·0	733	28	8 ,,
46	I	88·3	847	28	12 ,,
49	II	79·1	750	28	4 ,,
45	II	74·0	690	27	8 ,,
50	II	74·8	850	26	12 ,,
48	III	82·3	859	26	4 ,,
51	III	82·6	990	26	8 ,,
47	III	80·0	802	27	12 ,,

5. As the differences between individual plots exceeded the acceptable limits of 10% variation in basal area, 20% variation in number of stems and 15% variation in height, it was not possible to treat them as a single homogeneous block. They were, therefore, divided into 3 comparable sets of 3 plots each.

SUBSEQUENT MAINTENANCE

6. The plots have been carefully maintained and 'D' grade ordinary thinnings were carried out in accordance with the original prescriptions. The four year thinning cycle plots have so far been thinned four times in March 1940, March 1944, March 1948 and April 1952, the 8 years thinning cycle plots twice in March 1944 and April 1952, while the 12 year thinning cycle plots have so far been thinned only once in March, 1948. The usual full crop measurements (including the measurement of sample trees for volume computations) were carried out in plots which were thinned, while only the diameters of all the trees and heights of representative ones were measured in the case of the remaining plots which were not due for thinning then. In addition, the length of bole clear of (*a*) green branches and of (*b*) all branches, was measured directly with the tape for all the trees in each plot in April, 1952. In order to judge the comparative effect of the three thinning treatments on volume production up to 1952, representative felled sample trees, were also measured from the surrounds of the 12 year thinning cycle plots in April 1952, although these were not due for thinning then.

7. The basal area check over thinning intensity prescribed at the time of starting the investigation (c.f., para 2) broke down in actual practice as the basal areas marked in the

8 and 12 year thinning cycle plots on silvicultural considerations could not be reconciled with the figures derived on the basis of basal areas removed in the 4 year thinning cycle plots. The differences in individual cases were as high as 31% both in 1944 and 1948. It was, therefore, decided in 1944 to control the thinning intensity on the basis of the yield table number of stems and average diameter relationship, after making allowance for the fractional quality of the crop. This procedure has been followed for all the plots since 1944, and has resulted in the additional advantage of providing an independent objective check over the thinning intensity in the 4 year thinning cycle plots also.

COMPUTATIONS

8. The heights, diameters, basal areas and volumes for each plot on different dates have been computed on the lines laid down in Chapter X of "The Silvicultural Research Code Vol. 3—The Tree and Crop Measurement Manual". The mortality and diameter distribution figures and the lengths of clear bole are available for the individual plots. The data have been critically examined to determine the influence of the three treatments on the various aspects of growth. The differences in the development of diameters, basal area and volume, the incidence of mortality and the distribution of diameters show consistent trends and are generally quite appreciable. They have, however, not always proved to be significant in the statistical sense. The most probable reason for this appears to be the inadequate number of replications in the experiment, which allows only 4 degrees of freedom for the error variance.

HEIGHT GROWTH

9. The average values of crop* height and top* height for the three treatments, in March 1936, March 1944 and April 1952 were as follows :—

TABLE 3.—*Development of height from 1936 to 1952*

Thinning cycle	Height in feet					
	March, 1936 (after thinning)		March, 1944 (before thinning)		April, 1952 (before thinning)	
	Crop	Top	Crop	Top	Crop	Top
4 years ..	..	27	43	46	62	66
8 ,, ..	..	27	42	46	63	66
12 ,, ..	..	27	42	45	62	66

* Crop height and top height are estimates of the average height of the total crop and the average height of the tallest trees in the crop respectively. The latter, in practice, is derived on the basis of 100 largest diameters per acre.

10. The differences in the values of crop as well as top heights on various dates are thus non-significant. The top heights especially, are almost the same. Therefore, the lengthening of thinning cycle, has no effect on height growth of the crop.

DIAMETER GROWTH

11. A comparison on the basis of the average diameter values for the total crop will be justified only for the dates on which thinnings under all the treatments coincide. However, the trend of the influence of the different thinning cycles on the diameter increment of the crop may be studied by considering an equal number of top diameter trees from each plot. This procedure has the additional advantage of ignoring the thinner stems which normally get eliminated as the crop advances in age. The top diameter, i.e., the diameter corresponding to the average basal area of the 100 largest diameters at breast height per acre, has, therefore, been utilized for studying the development of diameters in the present case. Table 4 shows the average values of top diameter for each treatment after formation in March, 1936 and before thinnings in March, 1944 and April, 1952.

TABLE 4.—*Showing the average values of top diameters at different dates*

Thinning cycle	Top diameter in inches		
	March, 1936 (after thinning)	March, 1944 (before and after thinning)	April, 1952 (before thinning)
4 years	6·4	9·5	12·1
8 ,, ...	6·3	9·0	11·8
12 ,, ...	6·3	8·8	11·1

12. Maximum top diameter has, thus, been obtained with the shortest thinning cycle, whereas the longest cycle has resulted in minimum growth. These differences, however, have not turned out to be statistically significant. To examine the question more closely the data have been plotted in Fig. 1, which also shows the positions of the individual plots on the three dates. A study of the graph reveals the trends to be remarkably consistent. Whereas the positions of the plots for the three treatments were intimately mixed up in 1936, by 1952, the 4 year plots have generally come to the top, the 8 year plots occupy the middle position and the 12 year plots are all at the lower end. An analysis of these trends indicates the trend for the 12 year cycle is significantly smaller than either of those for the 4 and 8 year cycles at the usual 5% probability level while the difference between the trends for the last two cycles is not so. It is felt that the difference between the trends for the 4 and 8 year cycles would also have proved to be significant with a larger number of replications.

DIAMETER DISTRIBUTION

13. A study of the dispersion of stems among the different diameter classes under the three thinning cycles has yielded some interesting results. The detailed dispersion is given in Table 5.

Figure 3.

DISTRIBUTION OF STEMS BY DIAMETER CLASSES IN MARCH, 1944 (BEFORE THINNING).

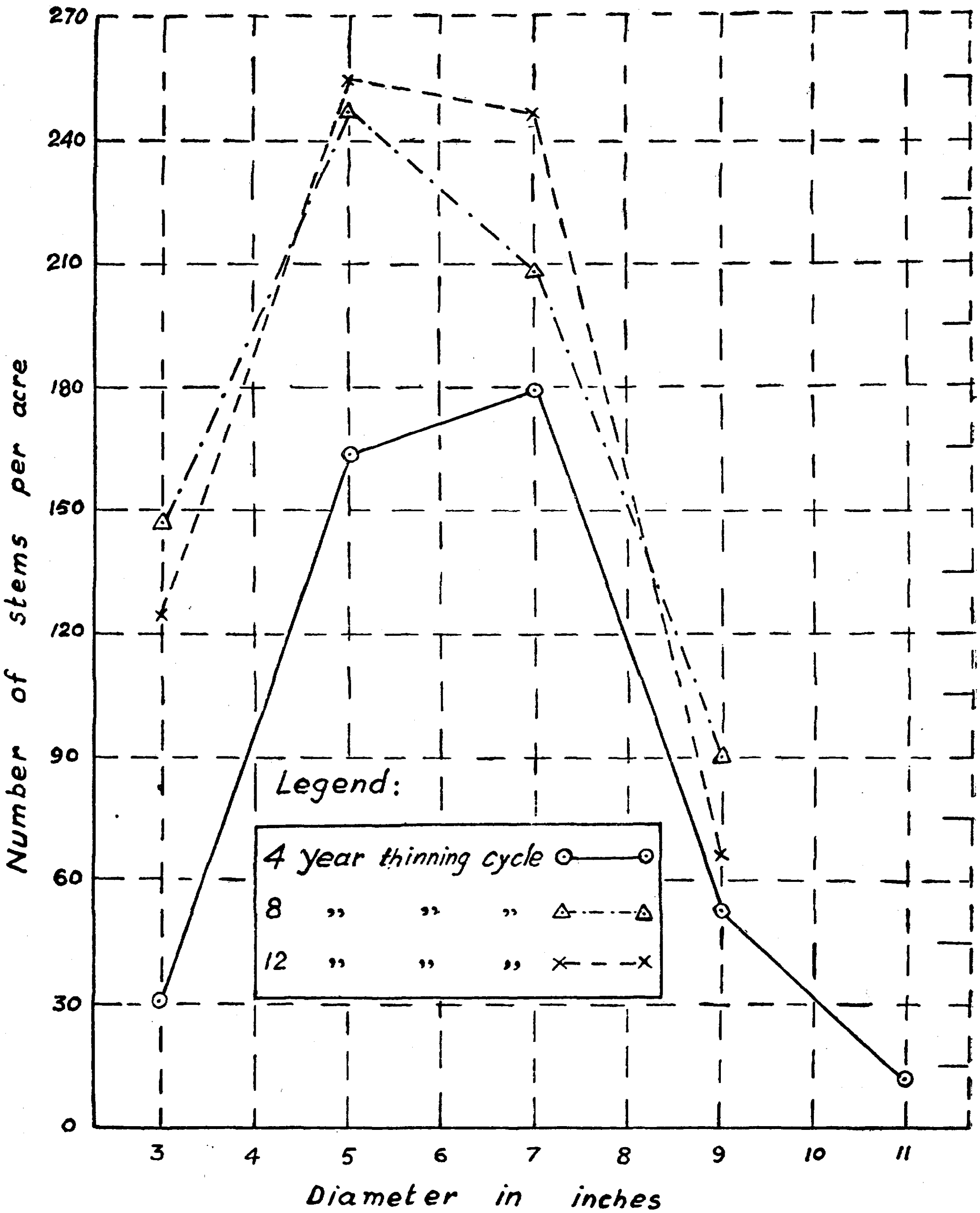


Figure. 4.

DISTRIBUTION OF STEMS BY DIAMETER CLASSES, IN APRIL, 1952 (BEFORE THINNING).

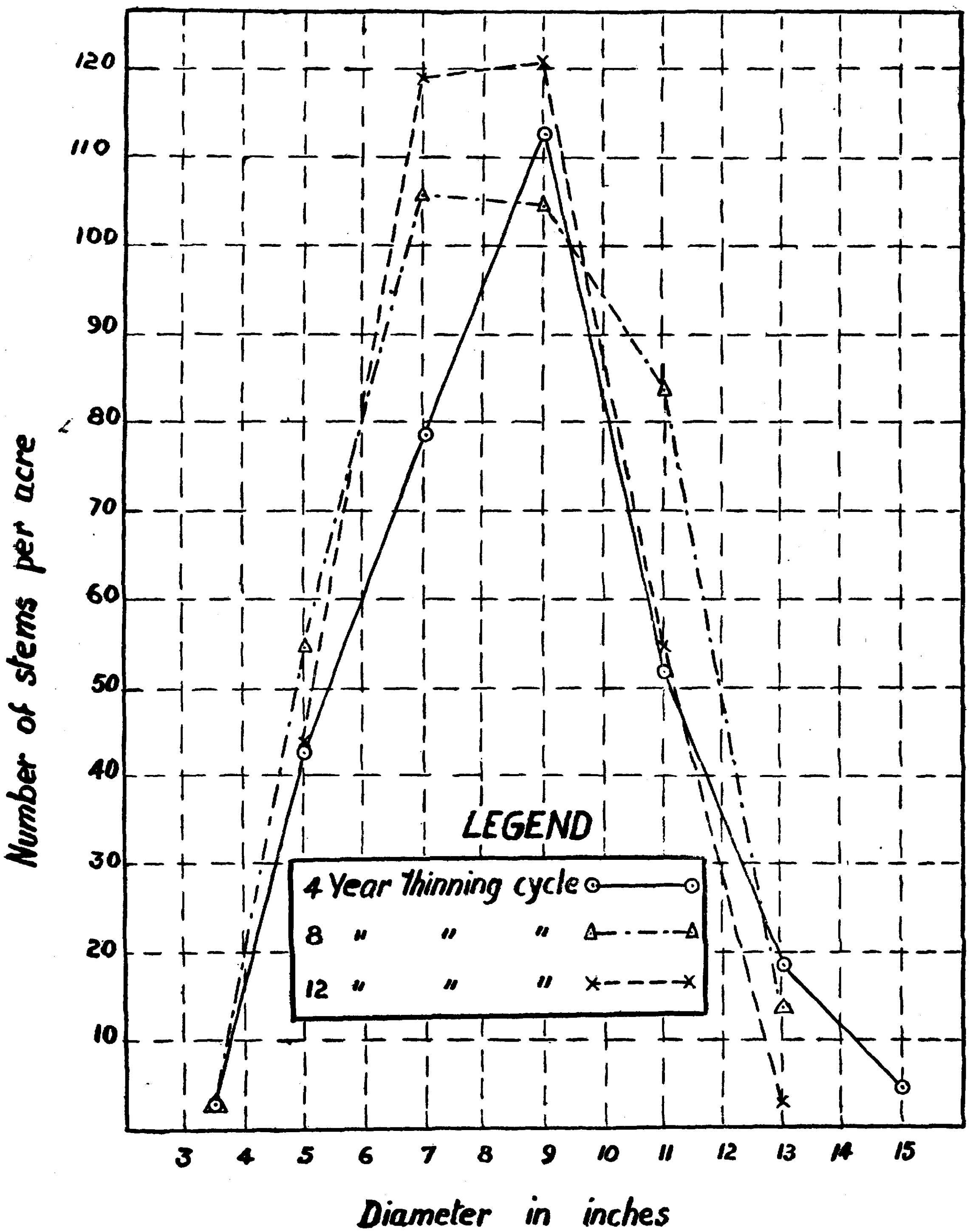


TABLE 5.—*Distribution of stems by two-inch diameter classes in March 1936, March 1944 and April 1952*

Diameter class (inches)	Number of stems per acre								
	1936 (after thinning)			1944 (before thinning)			1952 (before thinning)		
	4 yrs. cycle	8 yrs. cycle	12 yrs. cycle	4 yrs. cycle	8 yrs. cycle	12 yrs. cycle	4 yrs. cycle	8 yrs. cycle	12 yrs. cycle
0– 2·0	47	66	45	..	2	..	..	..	..
2·1– 4·0	365	289	328	31	147	124	3	3	..
4·1– 6·0	357	404	397	164	247	255	43	55	44
6·1– 8·0	35	44	24	179	208	246	79	106	119
8·1–10·0	..	..	..	53	90	66	113	105	121
10·1–12·0	..	..	..	12	..	..	52	84	55
12·1–14·0	..	..	..	..	..	..	19	14	3
14·1–16·0	..	..	..	..	..	..	5*	..	..

* NOTE :—The 5 stems are all less than 15" in diameter.

14. The above data have been utilized in preparing the frequency polygons given in Figs. 2 to 4. It may be noted that while in 1936, the 8 year thinning cycle plots had the maximum number of stems in the highest diameter class (6·1 to 8·0 inches) and the 4 and 12 year cycle plots occupied the second and third positions respectively, by 1944, the 4 year cycle plots took a clear lead over the remaining two, out of which the 12 year cycle plots were inferior. During the next 8 years the position became still more marked. Thus the overall effect of the shorter thinning cycle has been the development of more stems of higher diameter classes. This tendency falls off with increase in the thinning period.

BASAL AREA PRODUCTION

15. Table 6 given below, shows for each treatment, the detailed position regarding the basal area of the main crop in 1936, the basal area of the total crop in 1952, and the basal area removed in thinnings, after excluding the basal area of trees which died during the period. The total periodic increment and the periodic mean annual increment values have also been worked out.

TABLE 6.—*Development of Basal Area during the period March, 1936 to April, 1952*

Thinning cycle	Basal area per acre in sq. ft.				
	March, 1936 after thinning (age 10 yrs.)	April, 1952 before thinning (age 26 yrs.)	Removed in thinnings during the 16 yrs. period	Total periodic increment	Mean annual increment
4 years ..	81·1	135·0	54·4	108·3	6·8
8 ,, ..	80·5	151·0	37·6	108·1	6·8
12 ,, ..	81·0	132·2	35·6	86·8	5·4

16. The basal area production under the 4 and 8 years thinning cycles has thus been similar while there has been a sharp fall with a further increase in the thinning cycle. This is mainly accounted for by the heavy mortality (vide para 19 *infra*) in the last case. The entire data have been analysed statistically. The difference between the longest thinning cycle and either of the shorter ones is significant at 5% probability level.

VOLUME PRODUCTION

17. Following the standard Indian sample plot practice, crop volumes for each plot have been assessed under the sub-heads (*a*) stem timber* and (*b*) stem smallwood†. The recorded data, however, suffer from two defects. The volumes of the residual crops were not assessed at the time of formation. The routine volume measurements were again ignored in 1940 at the time of first thinning in the 4 year thinning cycle plots so that the total volume removed since 1936 in this case is not known. The crops in all the cases having grown under similar conditions till 1936 and being on that date comparable from the point of view of basal area and height, it may be safely assumed that the volumes of the residual crops were also comparable. A comparison between the performances of the two longer thinning cycle treatments thus becomes possible. Again since the maximum diameter at breast height of the trees removed in thinnings in the 4 year cycle plots in 1940 was 7·3 inches they did not contain any stem timber. Therefore, the total quantity of stem timber produced in this case also is known. The available information is presented in Table 7.

TABLE 7.—*Showing volume production till 1952 (excluding the dead and missing trees)*

Thinning cycle	Volume of total crop 1952		Volume removed in thinnings after 1936		Total volume production	
	Stem timber	Stem smallwood	Stem timber	Stem smallwood	Stem timber	Stem timber† stem smallwood
4 years ..	1,568	..	4	Unknown	1,572	Unknown
8 ,, ..	1,615	2,454	20	741	1,635	4,830
12 ,, ..	1,129	2,332	45	748	1,174	4,254

18. Thus, from the point of view of stem timber production the 8 year thinning cycle has, so far, given the best results, the 4 year cycle closely follows it, while the 12 year cycle is distinctly inferior to both. The quantity of stem timber produced under either of the shorter two thinning cycles is significantly larger than that produced under the 12 year cycle though the mutual difference of the first two is not significant. As already mentioned, the figures for total stem smallwood plus stem timber production for the 4 year cycle are not available. Of the remaining two, the 12 year cycle has resulted in considerably lower yield. This difference has not turned out to be significant due, probably, to an inadequate number of replications.

* Volume of the main bole, including stump, but excluding bark down to the limiting diameter of 8" over bark.

† Volume of the main bole, including bark, between the limiting diameters of 8" and 2" over bark.

MORTALITY

19. Table 8 gives the number of casualties for each treatment during successive 4 years periods. As would be expected the mortality rate has risen with an increase in the thinning cycle. While it is practically nil in the case of 4 years thinning cycle treatment,

TABLE 8.—*Showing the number of dead trees per acre for the three thinning cycles*

Thinning cycle	Number of dead trees/acre				
	1936–40	1940–44	1944–48	1948–52	Total
4 years ..	..	..	3	..	3
8 „ ..	..	110	..	23	133
12 „ ..	3	147	80	17	247

it has risen to 133 trees per acre with the 8 year thinning cycle treatment and to almost twice this figure under the 12 year thinning cycle.

The trend in mortality rate has been found to be statistically significant at the 5% probability level.

LENGTH OF CLEAR BOLE

20. In order to gauge the influence of the three treatments, on the quality of timber produced, the lengths of bole clear of (i) all branches and (ii) of green branches alone have been measured in 1952 for all the trees composing the main crop. As the thinnings under the three treatments have not coincided on this date and the number of stems present in each case is different, comparison has been based on 100 thickest stems per acre per plot. The results are shown in Table 9 below :

TABLE 9.—*Showing the length of clear bole under the three thinning cycles in 1952, after thinning*

Thinning cycle	Average length of bole in feet for 100 thickest trees per acre	
	Free of all branches	Free of green branches
	April, 1952	April, 1952
4 years ..	21	35
8 „ ..	20	36
12 „ ..	20	36

21. It is obvious that the length of clear bole is not materially influenced by the 3 treatments under trial. The quality of resulting timber will, therefore, have to be judged from the size of the resulting trees alone.

DISCUSSION

22. The investigation under discussion is one of the most comprehensive investigations so far laid out in India on comparative thinning research problems. It has been well maintained since the time of its start in 1936. The one serious objection, however, is the rather inadequate number of replications. This defect, as already stated, often does not permit an assessment of the significance of observed differences with confidence. The practical research worker, with some experience of this type of work in forest crops, would readily appreciate the difficulties involved in finding a more comprehensive set of initially comparable sample plots. The task, in majority of cases, proves to be almost impossible. This fact has been borne in mind at the time of assessment of results and the techniques of analysis have been varied accordingly.

23. Height growth, especially in terms of top height, has not been influenced by the period of the thinning cycle. As opposed to this, the three treatments have produced substantial differences in the development of diameters, the distribution of the stems in different diameter classes, the mortality rate and the basal area and volume production. With a shorter thinning cycle more trees of higher diameter are obtained than with a longer thinning cycle. This means production of higher grade timber, particularly because the length of clear bole has remained uninfluenced by the thinning cycle. The basal area and stem timber volume production have been practically the same with the 4 and 8 year thinning cycles, but have declined appreciably with a further increase in the thinning period. This suggests that with ordinary 'D' grade thinning, the thinning cycle should not be increased beyond 8 years even in the interest of maximum basal area and volume production. For production of quality timber a shorter thinning cycle is indicated.

24. Since the over-all effect of lengthening the thinning cycle and keeping the intensity constant is to make the crops grow under comparatively congested condition for a longer period and thus to simulate conditions prevailing under lighter grades of thinnings, this investigation indirectly indicates that, with high quality young *chir* crops, thinnings lighter than the standard 'D' grade, retard the total increment of the forest and as such should be avoided. It is quite likely that a heavier grade of thinning, with a suitable thinning cycle may also result in comparable or better yields. This point would require further investigation. It is interesting to compare *chir* pine with sal (*Shorea robusta*), which, growing under similar conditions and thinned at 5 yearly intervals, gives maximum basal area and volume production under the 'C/D' grade and shows a distinct fall with an increase in thinning intensity beyond the 'D' grade.

CONCLUSIONS

25. The conclusions based on this investigation are, strictly speaking, applicable only to high quality plantation *chir* crops of about 10 to 30 years in age. They could probably be extended to natural *chir* of good quality (say All-India I quality and above) in the early stages of development. It would be risky to apply them to poorer quality or older crops for which independent investigations will have to be carried out.

26. As would be otherwise expected, this investigation bears out that an increase in thinning cycle retards diameter development and reduces the number of stems in the higher diameter classes. The basal area and volume production are practically the same

under the shortest (4 year) and the medium (8 year) thinning cycles, while they show a sharp fall under the longest (12 year) thinning cycle. The mortality rate, which is practically nil under the 4 year cycle treatment, increases rapidly with increase in the interval between thinnings. The treatments appear to have had no effect on height increment and the length of the clear bole. It may, therefore, be said that the 4 year thinning cycle is to be preferred for producing maximum quantity of large sized *chir* timber as well as total volume. The interval between consecutive thinnings may be increased up to 8 years without influencing the basal area and volume increments, though a somewhat shorter thinning cycle is indicated to avoid the loss resulting from mortality. The 12 year thinning cycle appears to be positively harmful both from the point of view of quality as well as the quantity of produce. Also, since the volume increment does not increase with the lengthening of the thinning cycle, it is to be concluded that thinning grades lighter than the ordinary 'D' grade should be avoided for this species. The above indications would hold in the case of very high quality *chir* crops varying from 10 to 30 years in age. Further research work would be necessary for determining the optimum thinning cycle for crops differing in quality or in age.

ACKNOWLEDGEMENTS

The authors gratefully acknowledge the help received from Dr. K. R. Nair, Statistician, Forest Research Institute, Dehra Dun during the final stages of the statistical analysis. The computations and analysis of the voluminous data were done in the Statistical Section of the Silviculture Branch and the work of Shri B. M. Bhattacharya, Lower Assistant and Shri M. M. Singh, Computor deserve special mention in this connection.

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PROSOPIS SPICIGERA (LINN.)

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SUMMARY

Some silvicultural aspects of *Prosopis spicigera* (Linn.) as also some easy and cheap methods of seed collection, afforestation and reforestation with this species are dealt with.

INTRODUCTION

Apropos Messrs. Krishnaswamy and Gupta's article under the caption "Rajputana Desert – Its Vegetation and Soil" in the *Indian Forester* Vol. 78, No. 12 (December, 1952), pages 595–601 with particular reference to the last paragraph on page 597 "*Silviculture of the species and afforestation*" some suggestions are hereby offered on the "*Silvics*" of *Prosopis spicigera.*

This species is the ubiquitous tree of dry arid zones which manages to thrive in tracts with scanty rainfall of between 5 to 10 inches annually. It is said to be flourishing in Rajputana Desert and is to form one of the principal species in the proposed afforestation operations in this region.

Since no large scale operations have ever been undertaken in the past to afforest extensive tracts of land with this species, the available information on the "*Silvics*" of this species is very limited.

Troup, in *The Silviculture of Indian Trees* Vol. II, pages 389–99, has dealt *in extenso* with this species and it is not necessary to repeat anything therefrom. In *The Indian Forester* (June, 1933), pages 347–49, under the caption "*Kandi* (*Prosopis spicigera*) Forests in Sind", the writer has dealt with some silvicultural aspects of this species which may be found of some use : the intention of the present article is to describe some easiest, quickest and cheapest methods of afforestation and reforestation with this species.

AFFORESTATION

Seed Collection—Ripe yellow pods may be gathered from trees of all sizes either by :—

(i) shaking the pod-bearing branches with long hooked sticks, or
(ii) hand-plucking.

These should then be fed to penned cattle (bovine, goats and sheep), the dung and droppings whereof should be spread out to dry.

It is important that all cattle fed on these pods should be confined to a restricted area, in order to collect every grain of seed and the pen floor be dressed smooth and swept clean like a threshing floor.

The dry dung and droppings should then be threshed with three feet wooden beaters and the seed winnowed. The seed should then be filled in gunny bags and stored in some cool dry place, raised by a few inches from the floor.

Artificial Regeneration—Little attention was paid to the artificial regeneration of this species in the Sind forests prior to the operation of Sukkur Barrage (in 1932) because :—

(i) this species possesses a great power of reproducing itself by coppice shoots and root-suckers, and

(ii) then the unimpounded waters of Indus regularly inundated the Sind forests, thus helping this species preserve its vitality for a very long time.

Consequently Troup (1) has said very little on this aspect.

Construction of Sukkur Barrage canals and withdrawal of enormous quantities of water by these from the Indus resulted in cutting off of irrigation of the *Prosopis spicigera* forests of Sind. This reduced the coppicing and root-sucker-producing power of the species to an alarming degree and set the Sind foresters to attempting to solve method of regenerating the species artificially.

Methods—The following methods are in vogue and any one or a suitable combination of two or more methods is employed on one and the same area, viz. :—

(i) Broadcasting,
(ii) Dibbling,
(iii) Furrows,
(iv) Patches,
(v) Strips,
(vi) Trenches, and
(vii) Agriculture-cum-Forestry (*Taungya*).

Whereas Sind forests depend for irrigation, either on the river inundations or the Sukkur Barrage canal water, Rajputana Desert has only the rains to depend upon for the purpose. It will, therefore, be out-of-point to describe those methods as practised in Sind. Consequently, an attempt is being made herein to modify those methods so as to suit them to the desert conditions.

(i) *Broadcasting*—This should be so regulated as to obtain an espacement of approximately 5 feet in the resultant seedlings. The operation should be completed at least a fortnight before the expected break of the monsoon so as to enable the wind-blown soil to cover the seed to a depth of about 1/10th of an inch. The date of commencement of this operation will, naturally, vary with the composition of the soil – earlier in stable soils and later in loose soils subject to shifting.

(ii) *Dibbling*—This consists of digging pits with a spade, about one foot diameter and 2–3 inches deep – the soil of the pits being broken loose. Three grains of seed should then be thrown into each pit and lightly covered with loosened soil. The pits should be approximately 5 feet apart. This method is economical on seed but is slower and more costly in labour. It is, consequently, advocated for adoption in filling up of small blank patches or failures in other cheaper methods like (i) and (iii).

(iii) *Furrows*—To the handle of an ordinary plough, drawn by a pair of oxen or buffaloes, a long wooden or tin pipe with funnel-shaped top should be attached ; the lower end of this pipe should be about an inch above the heel of the plough. As the bullocks go on ploughing the land, the plough-man (who carries the seed in a satchel hanging from his shoulders, or suspended on the plough handle) should keep on lightly feeding the seed into the mouth of the funnel with his hand so that the seed should fall right into the furrow and get slightly buried under the upturned soil. With a little practice the plough-man will very easily feed the funnel evenly and with due economy of seed so as to obtain resultant seedlings between one to five feet apart in the furrows.

The furrows should be roughly ten feet apart, running in the direction of the prevailing breeze so as to catch minimum of sand deposit which, otherwise, in hot weather, will burn up the seedlings.

Large areas can thus be quickly and cheaply tackled.

(iv) *Patches*—This consists of sowing seed in selected patches in blanks, grassy and weedy areas by any one or combination of the methods described above.

(v) *Strips*—This method is suitable for such lands as :—

(*a*) as are either under field crops, or

(*b*) contain rank growth of grasses or other abnoxious growth.

Parallel strips 2–4 feet wide and 20–40 feet apart, running at right angle to the direction of the prevailing breeze, should be cleared of all undesirable growth and sown *broadcasting* or *dibbled* or in *furrows*. Strips laid out in the direction of the breeze are likely to provide dumping ground for the shifting sands.

(vi) *Trenches*—This method is applicable to lands under canal irrigation and as such it will be out of place in this article.

(vii) *Agriculture-cum-Forestry* (*Taungya*)—This method has a world-wide publicity ; consequently, any repetition thereof is unwarranted.

Spacing—In all the methods of sowing an intial espacement of 5–6 feet is adopted ; this is increased to 15–20 feet at the time of felling of the coupe.

All sowing operations should be so timed as to complete them some days before the first fall of the monsoon in order to take advantage of every drop of rain-water. Desert soil being friable, no difficulty should be encountered in dry ploughing the land.

Germination of Seed—Prosopis seed starts germinating a week after sowing and continues for another week or so.

Viability of Seed—Prosopis seed is hardy and will retain its vitality up to the next monsoon even in the event of non-germination of some seed during the first monsoon. This is a great asset when large areas have to be afforested, particularly in desert tracts where labour problem may be none too easy.

Quantity of seed required—Seed will be required at the rate of 5–8 seers per acre for *broadcasting* and $1\frac{1}{2}$–2 seers for other methods.

Rate of Growth—Seedlings attain a height of 6 to 12 inches in the first season ; in 30 years the trees grow 20 to 35 feet in height. Annual rate of diameter growth during the first 5–6 years is $\frac{1}{2}$ to $\frac{3}{4}$ inch ; later on the rate of diameter growth declines : ultimately an average girth of 2 feet 6 inches (B.H.) is attained in 30 years. In the case of coppice shoots, however, the rate of both the diameter and height growth is more rapid for the first few years (approximately double that of seedling) ; later on in the tree stage there is practically no difference between those from seed and coppice shoots excepting that the latter grow in a cluster from the mother stools while the former stands out single.

Prosopis juliflora (DC)—The seed of this species is also to be collected the same way as that of *P. spicigera*. *P. juliflora* pods are avidly eaten by donkeys and these animals too can be mobilized into seed-collection. Seeds of both the varieties should then be mixed in the proportion required and sown as above. This species has strong tendency towards gregariousness and will make a very effective sand-binder.

Tamarix articulata (Vahl.)—This species is recommended for introduction in the Rajputana Desert ; nursery stock from seed and Branch-and-Shoot-Cuttings planted in the inter-strips.

Mechanization—It may be possible to mechanize both the threshing out of seed from the cattle pens and sowing in the furrows as aforesaid ; in such a choice the relative costs and local conditions shall be the guiding factors.

REFORESTATION

Coppice and Root-suckers—*P. spicigera* is a good coppicer, and has a remarkable power of producing root-suckers ; stands containing a crop of this species can be very much be improved in density by digging, with a spade or adze, three concentric rings in the soil around the standing trees to a depth of six to nine inches ; this operation wounds the lateral roots and induces production of root-suckers. These rings should be $2\frac{1}{2}$ to 3 feet apart.

Stool of every tree felled should be trimmed flush with the ground so as to obtain healthy coppice-shoots and three concentric rings cut into the soil round the stump as above.

This will considerably cheapen the cost of reforestation. Further stocking, if required, should be obtained by direct sowings.

SUBSIDIARY OPERATIONS

Cleaning, Spacing and Thinnings—It is premature at this juncture to lay down anything *vis-à-vis* cleanings, spacing and thinnings. Circumstances prevailing at the time will offer the best advice. The object of management being to check advance of sands, it will probably be found advisable not to carry out any of these operations but allow nature its full play – periodically removing dead, dying and suppressed trees. Low hanging side branches of *P. spicigera* may be found to be of considerable help in achieving this desired protection.

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A BRIEF NOTE ON DATE PALMS

BY SHRI NANDAN BHARGAVA, *Jaipur*

INTRODUCTION

Dates have been recognized as a good source of nourishment in the Middle East and in those countries dates form a substantial part of the diet of the common man. The fruit can be consumed both in the fresh and the dried form. The best quality of fruit, when properly dried, forms a delicious and nutritive article of diet. The fruit which was practically unknown in the United States of America a century back, is gaining popularity and is one of the important fruits of the States of California and Arizona. In this country, during these days of acute food shortage, considerable quantities of this fruit are being imported from Iraq for distribution among the people. As dried dates are valuable source of energy and form a nutritive food, it is imperative that their cultivation may be extended to a great extent. With the exclusion of date growing areas from the Indian Union, consequent upon the partition, the problem of introduction of new date varieties and improvement of date palms has assumed great importance in view of the great nutritive importance of dates for human consumption as a cherished article of diet.

CLIMATIC REQUIREMENTS

In every advanced country of the World, the usual rule is to grow in a locality only those kinds of trees that are best suited for it, with the result that there are well-defined tracts for particular trees. But there is a general growing tendency to plant, even in a particular area, many kinds of trees though some of them do not suit the place. This not only lowers the quality of the produce but greatly reduces the returns.

The usual proverb, that 'dates require its head in fire and feet in water' describes in a nut shell its requirements in so far as it needs an extremely hot and dry climate with plenty of moisture at its roots.

SUITABLE AREAS FOR DATE CULTIVATION

The date is most catholic about its soil requirements and can be successfully grown even in the saline soils where other crops fail, though it does best in good soils. It requires very hot climate for its success and the only important point to be considered in selecting areas for plantation is that it should be free from rain especially during the ripening season. The suitable areas in the Union for pushing up date cultivation are the districts of Ferozpur and portions of the districts of Hissar, Gurgaon, etc., which are free from rains during July and August. Date cultivation can also be pushed up in suitable areas of P.E.P.S.U., Central Rajasthan and Madhya Bharat. It is a mistake, however, to imagine that it will grow even in water-logged areas.

PREVIOUS WORK

In the undivided Punjab the work in the improvement of date palm was first taken up and it was realized that the only way of bringing about improvement in date culture was to import best varieties of dates from the important date growing countries of Iraq, Iran, Mekran, etc. In pursuance of this policy, considerable number of date suckers were imported for trials and it was found that some of the famous varieties like Hilawi, Khudravi, etc., could be most successfully grown in the Punjab. This work was greatly pushed by the Fruit Section of the Agriculture Department and due to consistent efforts, Date Farms of

imported varieties were established at places like Muzaffargarh, Multan and Jhang. At the last mentioned place, the suckers were imported and planted only a couple of years before the partition. This work of introduction of imported varieties proved most successful and considerable areas were planted with dates from suckers obtained from the imported plants.

METHODS OF PLANTATION

The date plants can be raised by direct sowing of the seeds either with flesh on or without in a well-laid out and adequately protected nursery. But due to the various infections to which the seeds and the seedlings are liable, the chances of success are remote.

The general practice among date growers in the Punjab and elsewhere has been to plant the suckers in September only and this practice has been supported by various authorities. It has been held that suckers planted in Spring fail to grow. It is also a firm belief of the date growers that for success in propagation, it is necessary to plant suckers of the biggest size, some people preferring to plant suckers weighing as much as a maund each.

In order to test the soundness of the prevailing practice and belief in regard to the size of suckers and the best planting season, several trials involving about 4,000 suckers of local varieties, were carried out over a period of three years, the results of which are :

(*a*) Suckers of 1–4 seers each give as high a percentage of success as bigger suckers, suckers of even 1–2 seers having done well when planted in Spring.

(*b*) Suckers of a comparatively small size, viz., from 1–4 seers each give a better percentage of success when planted in Spring than in Autumn, while the suckers of big size show equally good results whether planted in Spring or Autumn.

(*c*) Spring is by no means a bad season for planting. February having given the best results.

METHOD OF REPRODUCTION

Flowering takes place in April–May and the fruits are ripe in July–August. The male and female plants being separate, the artificial pollination during a particular period plays an important part. It is a contrivance by which a bunch of flowers from the male tree is taken by a skilled grower to a female tree when flowers are ready to receive the pollen. He either shakes the bunch over the female flowers or brush them as may be found convenient. The flowering is gregarious and one has to be very quick and careful in pollination to achieve measurable success.

MAIN OBSTACLE IN PROPAGATION

The greatest obstacle to the extension of date area is the shortage of young plants (date-suckers). Unlike many other fruit trees, where thousands of nursery plants can be produced in a season by budding or grafting or cuttings, in the case of date palms only a small number of plants (date-suckers) can be produced from a date palm in its whole life. The suckers come out from the parent tree largely near the ground and after 15 years or so, date palm ceases to produce any suckers. It is for this reason that a very limited supply of suckers can be made available to the public locally against a heavy demand.

The only course for the extension of date area is to import either a large number of suckers from foreign countries for supply to the people direct or establish a big Government date plantation of one or two hundred acres mainly to serve as a progeny garden from where thousands of suckers might be supplied to the public at reasonable prices. But importation of suckers of good varieties from abroad is being rendered impossible due to restrictions imposed by various Governments on their export.

PYRETHRUM AND ITS FUTURE IN INDIA

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SUMMARY

Pyrethrum growing on a commercial scale was first taken up in India during the Second World War due to the cessation of supplies from Japan and diminution in the import from Kenya. Subsequently, pyrethrum cultivation in the country was more or less given up completely due to the discovery of synthetic insecticides such as D.D.T. and Gammexane which were considered to be more efficient. Besides the past attempts at the cultivation of pyrethrum were by no means a success in this country, the yields being abnormally low. But very soon it was revealed that the synthetic insecticides like D.D.T. and Gammexane had very many drawbacks and that it is inadvisable to use them indiscriminately. In the light of these findings the importance of pyrethrum again emerged out.

The past attempts at the growing of pyrethrum in India are brifly outlined and the methods of pyrethrum culture in other countries like Japan and Kenya have also been indicated in this article. The necessity for delineating the optimum zones for pyrethrum cultivation and determining the most suitable method of propagation by a co-ordinated scheme of research has been stressed. The future prospects are bright for the crop in India, given a plan for rational extension under a co-ordinated scheme of research and extension.

Perhaps there are few instances of plant introduction in India which have served to create as sudden and wide an interest for a time as pyrethrum, followed by a sudden deflection in public mind as to the plant's role in the economy of the country. During its short but checkered history pyrethrum began to vascillate from a position when it was the object of solicitous interest from the Central and several State Governments to a position bordering on almost complete neglect.

Pyrethrum (*Chrysanthemum cinerariaefolium*) was first introduced into India by the Kashmir Forest Department in 1931 (Chopra *et al*, 1947). But its cultivation on a commercial scale was taken up only during the Second World War consequent *to* the cessation of supplies of pyrethrum from Japan and the marked diminution in the import from Kenya. The position prior to the War was,.that Japan with about 75% of the World's pyrethrum production was the leading producer and supplier, with Kenya figuring as the second largest source. Of the then production, United States of America monopolized roughly 90% of the available supplies for the manufacture of insecticides. The discovery of D.D.T., Gammexane and similar synthetic insecticides led to a revolution in the control of crop pests and this had a phenomenal set back for the pyrethrum industry. India which had shown a vigorous spurt in the production of pyrethrum during the early period of the War, was soon faced with the problem of switching on to the use of the more efficient synthetic insecticides, the manufacture of which was mounting rapidly. India also found that pyrethrum production was far from being economic within her borders, the reported yields having been hardly more than 80 lb. per acre, as against 500 to 700 lb. in Japan (Bull. Imp. Inst., 1937) and as high as 600 to 1,000 lb. in Kenya (Ball, 1943). Under the circumstances, pyrethrum cultivation was rapidly relegated into the sphere of oblivion in this country. But this deliberate neglect of pyrethrum was soon found to be a mistake, as the results of the plant protection projects and the findings of research on the synthetic insecticides became available in increasing volume and from a

growing number of workers from all lands. That D.D.T. and Gammexane were not only no panacea but under certain circumstances were a source of positive danger was a fact that was soon revealed ; so much so, Governmental action was found necessary to regulate the use of these synthetic insecticides in order to safeguard the health of mankind and other animals. One of the first revelations of such research was the deleterious effects of D.D.T. on certain mammals. Research showed that milch cattle fed with fodder treated with D.D.T. yielded milk with such high concentration of the chemical as to be toxic to consumers of milk. Although D.D.T. was very effective against several crop pests, it also incidentally destroyed the balance in nature by the elimination of the beneficial parasitic insects. In certain insect pests a perceptible development of resistance to D.D.T. was also noticeable. According to Dr. Boyce of California University, the use of D.D.T. and Gammexane has created as many problems as solving them. He is also reported to have stated that the "baby food" industries in the U.S.A. have now practically tabooed the use of all cereal raw produce that had been subjected to D.D.T. treatment. Similarly, by the use of Gammexane vast quantities of edible fruits had to be rejected as culls unfit for human consumption. No wonder, therefore, that in the light of these findings the importance of pyrethrum again emerged out as of very significant importance in man's fight against the destructive pests.

The first spurt of development of pyrethrum in India is found to have taken place sometime in 1941, when a little over 300 acres were planted with this crop in Kashmir State. In the course of about five years, the area in Kashmir was increased to 2,100 acres (in the year 1945–46) with an annual production of 176,000 lb. of dried pyrethrum flowers (Chopra *et al*, 1947). Nilgiris and Palnis in Madras, Shillong in Assam and Kumaun hills in U.P. were other centres of pyrethrum cultivation started at the instance of the Department of Supply of the Government of India. The records show that during 1945, nearly 1,800 acres were under this crop on the Nilgiris and about 500 acres on the Palnis, with a maximum provincial output of 97·9 tons of dried flowers. Actual yield figures reported by the Madras Forest Department for the years 1944 to 1947, show the annual mean acre yield only between 53 and 58 lb., which reveals the relatively backward pyrethrum production conditions in this country, in contrast with those in Japan and Kenya. Comparable figures for Assam and U.P. are not available to the author but it is surmized that neither the acreage nor production was of sufficient magnitude to merit notice.

It is a matter of common knowledge, that like all other cultivated crops, yield in pyrethrum is subject to cumulative influences of a multitude of factors – soil, climate, propagation, crop husbandry, method of processing, and above all the inherent yielding capacity of the strain. Since the value of pyrethrum is appraised on the pyrethrin content, the gross yield of flowers will not by itself lead to a proper evaluation of conditions existing for pyrethrum crop planning. A discussion on the future of pyrethrum industry in India has, therefore, to proceed on the consideration of all these foregoing factors.

After a careful study of the Indian experience on the growing of pyrethrum, Burns (1941) opines that the crop thrives best in a comparatively dry climate and a well drained light soil, with a tendency to damp off during the monsoons. He presumes that the temperate outer Himalayas are suitable for the crop. On the other hand Chopra (1947) holds the view that the most profitable zone for the crop lies between the altitudes of 5,000 to 8,000 feet above sea-level, though at about 6,000 feet elevation in Kashmir the highest pyrethrin content was obtained ranging up to 1·05%. Study of pyrethrum culture in other lands has led some authors to conclude (Gnadinger, 1936) that the crop thrives best on well drained calcareous soil with a mild climate throughout the year, high relative humidity and a long growing season. Ball (1943) citing Kenya experience concludes that a high altitude of over 7,500 feet and an evenly distributed rainfall of 40 to 45 inches are the optimum for the crop leading to a yield

of as high as 1,000 lb. of dried flowers per acre. In an excellent contribution on the subject by the Imperial Institute (1937), it has been recorded that under Japan conditions a comparatively dry climate and well drained sandy soil are the prerequisites for success and that even mountainous waste lands would suit the crop provided the climate and soil are not damp.

It is possible to glean out from the varied experiences of the workers, that a similarity of conditions neither exist in all pyrethrum growing countries, nor is it possible to assure the optimum climate and soil even if we had a knowledge of these essential requirements. Indian experience has only served to indicate broadly the optimum zones for the crop, but it will be premature to define the best areas in each region. Though the yields obtained from pyrethrum plantations in India have been poor in the past it cannot be said that there are no suitable areas in the country for the cultivation of this crop. Pyrethrum is being grown on a small scale by the Madras Agricultural Department at the Pomological Station, Coonoor from 1937 and yield up to 230 lb. per acre has been obtained from this area (Madras Agri. Stn. Reports, 1940–41). As regards pyrethrin content also it has been reported that as high a percentage of pyrethrin as 2·237% has been obtained from pyrethrum grown at Nanjanad by the Madras Agricultural Department (Rao, 1950).

The only possible conclusions that can be arrived at with the existing information is that high elevations and dry weather conditions are essential but the delimitation of the optimum growing zones in each region or State has to be done yet on the basis of actual trials under a co-ordinated plan. If this view is accepted, large scale ventures under the varied conditions prevailing in a tract like the Nilgiris or Kodais can only be undertaken after the preliminary tests in the form of numerous plots under a co-ordinated plan of investigations are completed.

Propagation—It has been almost the universal practice to raise pyrethrum from seed for commercial planting. Seeds are sown in raised nursery beds either in March–April or in September–October and the seed rate is approximately 1 lb. per acre. In Japan, before sowing, seeds are thoroughly soaked in water, wrapped in cloth or sacking and buried in damp sand for four or five days after which they are mixed with dry sand, and sown evenly in small quantities. It is also the practice in Japan and Kenya to provide seed beds with overhead shade as well as a covering of grass. Germination takes place in 12 to 15 days after which the surface cover of grass is removed. In Dalmatia seeds are sown in hot beds (Gnadinger, 1936). Seedlings are transplanted into the field when 6 to 7 weeks old, that is, when they are about 4 inches in height.

Propagation can be effected by splits (root and shoot divisions) also and there is a divergence of opinion as to the relative importance of seedlings versus splits for raising commercial plantations. According to Ball (1943) the consensus of opinion in Kenya is that it is easier to establish a field with seedlings since they possess a better root system to withstand unfavourable conditions, though they involve a greater expenditure and supervision in raising seed beds. He also considers that plants raised from splits come into flower earlier. In Japan also splits are sometimes used for propagation but it is claimed that in comparison with seedling plant they make poor growth and give pickings over a shorter period of time (Bull. Imp. Inst., 1937). On the other hand, by conducting experiments at the Pomological Station, Coonoor, by the Madras Agricultural Department over a period of four years, it has been concluded that there exists a significant positive correlation between the yields of progenies and their parents and that, for the purpose of upgrading the yield, the selection of high yielding parents and raising vegetative progenies thereof is of considerable practical importance (Rao *et al*, unpublished). Contrary to this it is said that pyrethrum plant is self sterile and, therefore, it is not desirable to attempt establishing a plantation from one or two high yielding plants propagated repeatedly by splits and that it is necessary to have a large number of

individuals in the field to ensure adequate pollination (Ball, 1943). From the foregoing, it is evident that for the future of pyrethrum crop planning in India, not only is it necessary to delineate the suitable zones for the cultivation of the crop but also to evolve the ideal method of propagation suitable to each tract. The possibility of propagation by the selection of high yielding vegetative strains in order to step up pyrethrum yields also needs further detailed investigation.

Crop Husbandry—As in all other aspects of pyrethrum culture, there is a great leeway to make towards the determination of optimum plantation practices for the varied growing conditions in this country. It has already been mentioned how special seed bed conditions have been found necessary in Dalmatia while under the less rigorous climatic conditions of other countries the nursery or seed bed practices are necessarily different. Shading of plants in the nursery is another practice that has been found useful in Japan and Kenya. There has also been a great deal of diversity with regard to spacing of plants in plantations. While the usual spacing adopted in India is 18×18 inches, in Kenya the spacings range from 20×20 inches in lower elevations where the growth is not so vigorous to 2×2 feet in higher altitudes where the conditions of growth are most favourable. On rich forest soils where rooting is loose and weeding expensive, the practice in Kenya is to have the lines spaced as wide as $2\frac{1}{2}$ to 3 feet with plants in each line spaced at 18 inches. In Japan the planting lines are 1 to 2 feet apart with seedlings in the lines spaced 7 inches to 1 foot apart.

In regard to manuring of plants too, while Japan holds that application of manures such as night soil, plant ash, fish cake, superphosphate of lime is useful in fostering better yields, experience in Kenya is against all such practices. In fact, it has been claimed in Kenya that all such supplements may be deleterious to the crop (Ball, 1943). In experiments conducted at Nanjanad by the Madras Agricultural Department, manuring has contributed to the lowering of yields in comparison with the unmanured controls but regarding pyrethrin content, a dressing of superphosphate and bonemeal in equal quantities to supply 50 lb. of P_2O_5 per acre has given the maximum percentage. (Rao, 1950). However, it is reasonable to assume that in badly eroded soils of low fertility, any measure that will promote a good crop stand and growth would eventually be reflected in better yields. These then point out to the need for a proper adjustment of the plantation practices to suit the multiplicity of conditions prevailing even under a given altitude. It is, therefore, inferred that in any well thought out plan for pyrethrum extension, emphasis should be laid not merely on climate and soil, as has been the erstwhile tendency, but also on all those equally effective contributors towards the ultimate success of the crop such as the genetic constitution of the plant and the response of the plant to the varied practices of crop husbandry.

Processing and Storage—It is only after a successful crop is raised that the problem of processing the flowers to conserve the maximum pyrethrin content arises. In regard to these the proper stage of picking of flowers would seem to be as important as the treatment to which the flowers are subjected after harvest. Flowers appear usually during May–June and the proper time to harvest is when the disc florets are three-fourths open. It is said that at this stage the flowers contain the maximum percentage of pyrethrin. As for the processing, the universal experience seems to be that sun drying is all that is necessary where weather conditions permit, though the possibility of improvement through processing under controlled conditions cannot be ruled out. It has to be admitted that all these problems have to be regarded as of secondary importance deserving attention only after we have tided over the problems of delimiting the optimum zones, determining the ideal plant material in propagation practices and devising the most economic and suitable plantation practices.

Conclusion—From the general discussion of pyrethrum growing under Indian conditions it seems safe to conclude that despite all the hampered progress in the past, the future prospects

are bright for the crop in India, given a plan for rational extension under a co-ordinated scheme of research and extension. Many laudable scheme of national interest has received a setback through the detached or unco-ordinated efforts made by several agencies. Pyrethrum is no exception, but in the case of this crop too the disconnected trials of the past have provided us with ample material such as to enable us to plan effectively for obtaining more fruitful results in the future.

The author desires to express his indebtedness to Dr. K. C. Naik, M.Sc., Ph.D. (Bristol), Deputy Director of Agriculture (Research), Madras and Shri U. Narasinga Rao, B.Sc. (Ag.), Fruit Specialist, Coimbatore, for furnishing suggestions and some material for the compilation of this paper.

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RECOMMENDATIONS OF FORESTRY BOARD

The Central Board of Forestry concluded its five-day session in Dehra Dun on Sunday after making recommendations on several matters relating to forests and forest policy. Dr. Punjabrao Deshmukh presided. Among the resolutions adopted are :—

1. The Central Board of Forestry welcomes the national forest policy as enunciated by the Government of India in May, 1952 and commends it for implementation to the States. It requests them to take an early decision in respect of the proportion of land to be permanently maintained under forests, and to explore the possibility of introducing forest labour co-operative societies in forest exploitation, on the model of Bombay. The welfare of forest tribes should take precedence over the general concept of getting the maximum price for forest produce, and suggests that a detailed survey should be undertaken, in the first instance, in problem areas.

2. The Board (*a*) recommends to the States that the consolidation of holdings should be so effected as not to endanger the safety of trees growing on village lands, (*b*) suggests the establishment of community projects to wean the tribes from their age-long practice of shifting cultivation ; the States concerned are requested to take early action in the matter ; and the Board (*c*) urges the need for wide publicity in respect of the value of forests both in the economic and physical fields, emphasizing in particular protection against fire and the creation of wind belts.

3. The Board recommends that the schemes relating to the prevention of the encroachment of desert in various States should be co-ordinated with the Central scheme of the " Immobilization of the Rajputana desert ". This co-ordination can best be effected through a committee on which the States concerned should be represented.

SOIL CONSERVATION

4. The Board urges the need for expediting the implementation of the Soil Conservation Scheme drawn up in accordance with the recommendations of the Planning Commission. It considers it essential that the Soil Conservation Board, envisaged in the scheme, should be associated with the conservation scheme at the time of the consideration of river valley projects, in respect of soil conservation measures, provision for which should invariably be made in the upper catchments of the valleys concerned.

5. Whereas the number of candidates to be trained for service in individual States is small, and there is need for ensuring uniform high standards of training, the Board recommends that the Central Government should continue to undertake the responsibility of training of superior forest officers and rangers for all the States of India. It considers that it is not advisable for the States to attempt to run their own training centres for rangers and officers.

The States are, therefore, requested to make the fullest possible use of the training facilities provided by the Centre ; and the Board advises the States to plan their recruitment of officers and rangers on a systematic basis, in order to build up a properly balanced cadre and maintain a steady flow of recruits to the training centres.

6. The Board requests the Central Government to organize regional training courses for subordinate forest officers wherever necessary, as it is considered essential that the lower ranks of the forest service should also be properly trained in view of the rapid development of forestry in India and the expansion programme envisaged in the Five-Year Plan.

The Board approves the proposal of the Inspector-General of Forests to extend the course of Superior Forest Officers at Dehra Dun from two to three years, as specified later, and recommends that the first six months of the third-year should be spent in practical training in the States and the next six months in the Forest College at Dehra Dun.

7. The Board recommends that special legislation may be enacted by the States concerned to control the sale and trade in *biri* leaves, and that the legislation so enacted should follow a common pattern, as uncontrolled sale of *biri* leaves on private lands is detrimental to the *biri* industry and is prejudicial to the interests of workers engaged in it. It takes into consideration the fact that these leaves bring a revenue of over Rupees one crore to the States and an equal amount to private owners as well as workers engaged in the industry.

WILD-LIFE

8. Whereas India's heritage of wild-life is fast becoming a vanishing asset in respect of the country's notable animals such as the lion, rhinoceros, *cheeta*, etc., the Board endorses the recommendations made by the Indian Board for Wild-Life at its inaugural session held at Mysore in November, 1952. In particular, it draws the attention of the State Governments to the need for taking very early step to constitute State Wild-Life Boards in States where they have not yet been formed, and for an early enactment of necessary legislation for the protection of wild animals and birds as recommended by the Indian Board for Wild-Life.

SUPPLY OF RAILWAY SLEEPERS

9. The Board recommends that, in the interests of efficiency, economy and sustained supply of wooden sleepers to the State Railways at reasonable rates, it is necessary to plan sleeper production on a three-year basis ; that the number of sleepers to be supplied annually should be fixed ; and that sleeper prices should be fixed by negotiation for a period of three years for a given State or a group of States. It draws the attention of the States and the Railway Board to the need for taking a rational view while negotiating prices of railway sleepers. The Railway Board should take necessary steps to ensure speeding up of the movement of timber, and to that end step up its priority. The Railway Board is requested to arrange for prompt payment for passed sleepers ex-depots at railheads.

10. The Board suggests that *babul* trees be tried in waste lands wherever possible.

11. The Board urges that experiments be carried out with a view to introducing the Malayan type of cane in suitable localities in various States.

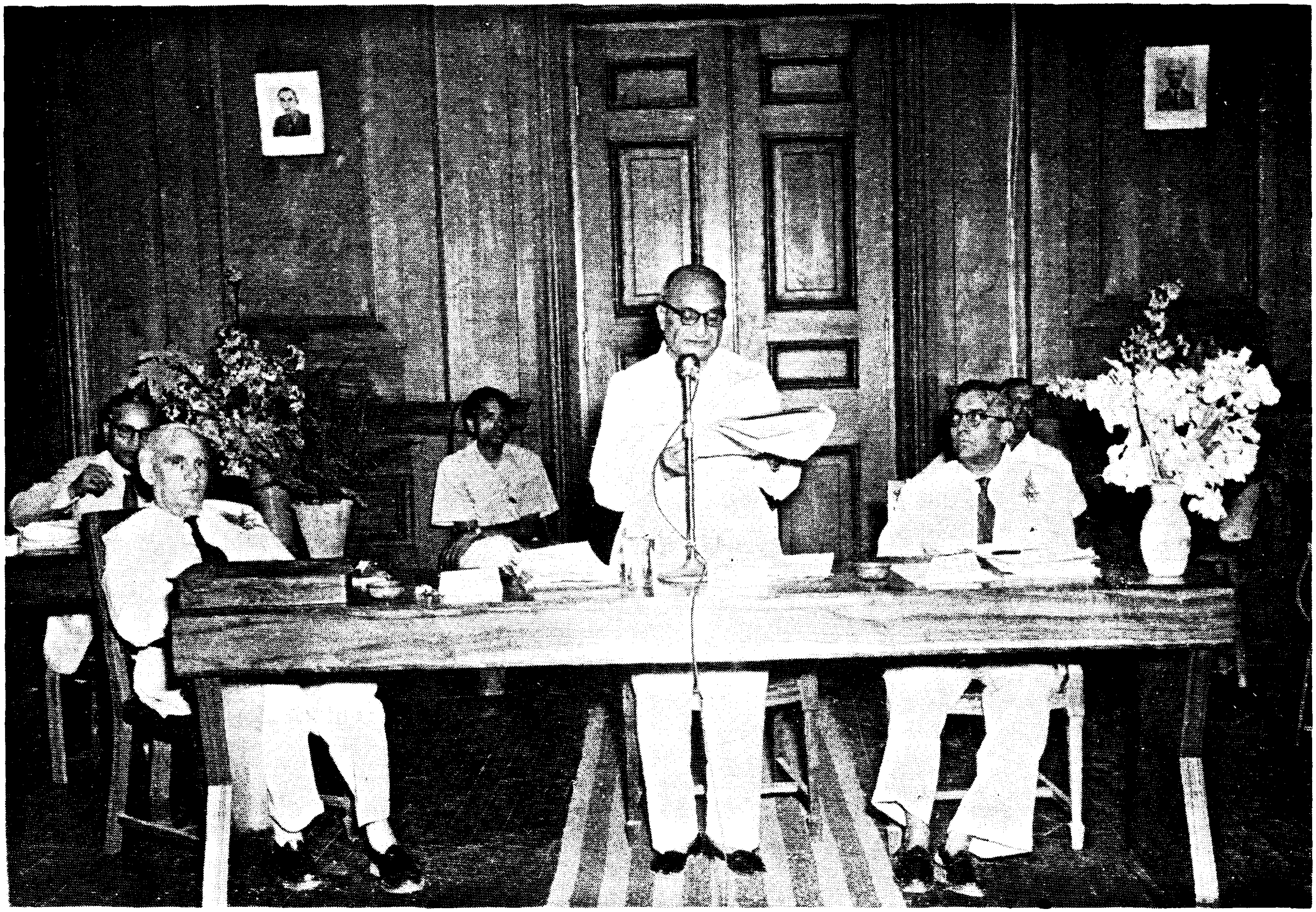
12. The Board recommends that investigations be carried out with a view to utilizing chips of wood, saw-dust and agricultural wastes, such as paddy husks and groundnut shells not fully utilized at present, by compressing them into suitable briquettes for use as fuel.

13. The Board draws the attention of the States to the World Forestry Congress to be held at Dehra Dun in 1954 and requests their co-operation in the contribution of papers, organization of excursions and the loan of officers.

F.A.O.'s TRIBUTE TO INDIAN EFFORTS

Mons. Francois, representative of the F.A.O., addressing the plenary session said :

"It is not customary for F.A.O. to send officers to national forestry meetings where countries formulate their own forest policies. The exception made in this case be fully justified by the fact that your first meeting had not only national but also international consequences, and that the second may be expected to yield the same important results.



Hon'ble Minister P. S. Deshmukh addressing the Board of Forestry meeting 1953.

"Two major events of international interest followed your first meeting. The first was the publication by the Government of India of its new National Forest Policy, which came out only four months after the recommendation made by the general F.A.O. Conference of 1951 to all member Governments concerning the adoption of a sound basic principles of forest policy. The Indian delegation was particularly helpful in the final drafting of these principles. More significant is the example set by India in its immediate compliance with the Conference's recommendation. This had a determining influence, not only on several countries which have already followed this example or which have declared their intention to do so but also on countries which have finally understood that a forest policy is necessary both for the conservation of their lands and for their economic and social development.

"It was also on the initiative of the Indian delegation that the Conference recommended to all member Governments the celebration of 'tree festivals', similar to the *Vana Mahotsava* celebrations which have been so successful in this country, not only from the practical point of view of afforestation but also in creating a forest consciousness among the people. Great interest has been shown by all Governments on this subject : countries which already held such festivals are planning to enlarge their scope, and those which did not hold them are requesting relevant information from F.A.O. and from other countries. If we can give an international significance to such celebrations, this simple gesture of planting a tree may well become a symbol of peace and co-operation between all nations of the world.

"In view of what has already been done by India for the promotion of international forestry, we in F.A.O. are particularly grateful for the generous offer made by this country to take charge of organizing the fourth World Forestry Congress. It is an onerous task, but one which may greatly benefit both Indian foresters and their visitors. No effort must be spared to make this Congress a success which will more than stand comparison with the three preceding ones held in Europe. F.A.O. is confident that you will achieve this result, and its Forestry Division is ready to give you its full support and help".

A NOTE ON COASTAL PLANTATIONS OF *CASUARINA EQUISETIFOLIA* IN NORTH KANARA

BY P. G. UBHAYAKAR

Surveyor, Forest Department, Karwar

A casual glance at the *Casuarina* trees on the vast coastal stretch of North Kanara, makes one conclude that this species is not indigenous to that tract. The formation of leaves itself is unlike that of other species growing locally. Almost all trees of this tract have either broad or narrow leaves visible to the naked eye ; but this tree species appears leafless with drooping branches and branchlets which perform the functions of leaves.

This species was first introduced in India in 1868. It is commonly called as "Beefwood of Australia", perhaps on account of the colour of the wood seen just after debarking. Though it is an exotic it grows well and rapidly on the sandy beaches. It thrives best near the sea-shore on loose sand within a few yards of the high tide level.

2. This species made its way into Karwar in 1868–69, when a small area was planted up near the sea-shore, probably for its aesthetic value. Some trees were also planted as avenue trees on both sides of main roads in the town. In succeeding years, plantations were extended whenever and wherever possible. From 1874–75 formation of new plantations started and gradually extended. Regular planting of *Casuarina* under a systematic programme started from 1879–80 in Binge, from 1885–86 in Arghe, and from 1888–89 in Harwada. In Kasarkod in Honawar *Taluka* plantations were started from 1882–83. In the meantime some plantations suffered a lot from erosion and tidal storms during monsoons. For some time planting was held up but again started regularly in 1890 and was since then regularly extended during succeeding years. At Gangavali in Kumta *Taluka*, plantations were started in 1903–04 but these were afterwards felled and the entire area was disforested in 1921–22 as adjoining people wanted that area for use as cattlestand. In about 1908–09, new accretions of about 168 acres in Chitakula (near Karwar) were handed over by the Customs Department to the Forest Department. In this way *Casuarina* spread itself on the sandy shores of our District.

3. In 1910 these *Casuarina* plantations were brought under regular working plans. The working plans for plantations at Chitakula, Kodibag, Binge and Arghe in Karwar *Taluka*, at Harwada in Ankola *Taluka* and at Gangavali in Kumta *Taluka* was framed by Mr. R. S. Pearson. The one for Kasarkod and Haldipur plantations in Honawar *Taluka* was written by Mr. W. E. Copleston. In 1921, these working plans were revised with a view to reducing the rotations prescribed in the former plans. The working plan for Chitakula, Kodibag, Binge and Arghe plantations was revised by Shri R. A. Hemmadi and that for Kasarkod and Haldipur plantations, by Shri M. S. Taggarse. The Harwada plantations were perhaps omitted through oversight. The workings as per prescriptions of these revised working plans continued till about 1934–35. These plans were agains revised in 1935–36 by Shri E. T. C. Vas, the then Divisional Forest Officer, Western Division Kanara. This time Harwada plantations were included. The operations under prescriptions of this revised plan have since been continued. The felling operations started from 1935–36 and replantings from 1936–37.

4. The area covered by this Working Plan is as follows :—

Felling Series	Range	Village		Area covered by the plan excluding areas of tanks therein
F.S. I	Karwar	Chitakula	..	199 ·00 acres
		Kodibag	..	48 ·40 ,,
		Binge	..	39 ·60 ,,
		Arghe	..	143 ·90 ,,
		TOTAL	..	430 ·90 acres
F.S. II	Ankola	Harwada	..	111 ·00 acres
F.S. III	Honawar	Kasarkod	..	415 ·50 ,,
		Haldipur	..	128 ·00 ,,
		TOTAL	..	543 ·50 acres
	Total for 3 Felling Series		..	1,085 ·40 acres

The rate of growth varies to a great extent from place to place. In Felling Series I and II, the average growth is faster then that in Felling Series III. Even then, in all these plantations patches of distinctly poor growth and also, small patches of blank areas are not uncommon. But on the whole the plantations are in good condition. The sandy soil, climate and other conditions of this locality suit *Casuarina* eminently. Taking into consideration the rate of growth, the operations in Felling Series I and II have been regularized under 15 years rotations and those in Felling Series III, under 20 years rotation.

6. This species is liable to various types of injuries either natural or artificial. Among natural injuries can be included cyclones, tidal erosion, insect attacks at various stages of growth of the plants, fungus attacks and fires. The artificial injuries are mainly by way of illicit cuttings and trampling by cattle.

Cyclones and wind damage—No protection can be had against severe cyclones but for those of a smaller degree, the system of keeping 4 rows of close-planted seedlings along the wind-ward side, i.e., the sea-board, is adopted with fair amount of success.

There is absolutely no protection against tidal waves. Large areas are at times washed away. Planting up is then done on such areas in the year when they are due for planting.

Insect attacks—Seeds are a delicacy to red ants and they damage large quantities of seeds sown on nursery beds. Precautions are, therefore, taken to raise nurseries on stilts in pools of water and a thin layer of ash is spread over the beds. The stilt beds afford protection against land crabs who nibble at the seedlings. A cricket (*Brachytrypes achinatus*) helps itself freely with the tender seedlings by nipping off the roots. The only solution is to select pencil-sized seedlings while transplanting into the field.

In 1947–48 and 1948–49 investigations into this cricket pest in *Casuarina* plantations were carried out by the Systematic Entomologist, Forest Research Institute, Dehra Dun, and the species of the pest has been identified as *Gymnogryllus humeralis*.

A root fungus, *Trichosporium vesiculosum* does occasional damage to the plantations. If the stools of felled trees are not unearthed this fungus soon appears on these decaying stools and its spores are then carried by wind on to the neighbouring seedlings. As a protective measure people living near the plantations are encouraged to unearth the roots for firewood. But when allowing to remove such roots vigilant care is taken to see that illicit fellings are not done under this garb.

In some plantations, *Loranthus* is also making its way ; so while undertaking thinnings in such plantations, trees infested with this parasite are removed.

Fires are rare in these plantations because this species does not allow grass to establish under its shade and a dense mat of its branchlets is formed. But this species is susceptible to fire. In most of the plantation areas the dry fallen needless of *Casuarina* are swept and taken away by villagers for fuel. This reduces fire danger to a great extent without any additional cost to the Department.

7. Though the heartwood of *Casuarina* species is hard with its weight of 55 lb. to 62 lb. per c.ft. it is liable to crack and split badly and hence is not durable. It has a high calorific value and on account of this it has a great demand in the market as fuel. Its chief markets are Mangalore and Bombay. In Mangalore it is used in Kilns in tile factories Recently it has made its way into Cutchmandavi (Kathiawar) and other markets. Sometimes good poles are also exported for being used as posts for temporary sheds and scaffolding-work, mostly in Kathiawar. But of late poles are not being extracted because, the wood as a fuel has greater demand.

8. It would be of interest to give the technique of raising this species in this locality. The method of regeneration since its introduction here, has remained the same with minor changes.

Seed is collected in September or October by shaking the cones picked from healthy trees 10/15 years of age. It is then broadcast in the beds prepared for the purpose on raised platforms and the beds are watered daily. The seed beds are covered with straw or palm leaves until germination is completed. For beds, pulverized light porous soils is used. The nurseries are fenced well to protect them against damage by cattle. To protect the seed beds against ant-attack, a light layer of ashes is maintained over the seed beds till germination completes. The germination starts generally after about 5 or 8 days from the date of sowing and the straw or palm leaf-cover is removed after about a fortnight, by which time the germination will be over. When seedlings grow to a height of about 3 or 4 inches, they are transplanted into prepared nursery beds on the ground, at a spacing of 3×3 inches or 6×6 inches, depending on probable rate of growth. The seedlings are retained for nine to ten months in these nurseries and when they attain required growth of $1\frac{1}{2}$ to 2 feet high, and of about pencil thickness, they are taken out and planted in felled coupes, made ready for the purpose at the requisite espacement.

No special measures are taken for preparation of soil as they are unnecessary. The coupes clear-felled in the previous year are got fenced by the purchaser at his own cost. Aligning is then done at 12×12 feet square, some 3 to 4 rows along sea-board are aligned at 6×6 feet to serve as a shelter belt against strong winds and storms.

The nine-month old seedlings raised in nurseries are taken out and planted at the regularly aligned stakes. The seedlings are tied to these stakes as they require support in the first year. Some weak seedlings require support in the second year too. After rains, the plants require watering. Each plant is watered once in 3 days for one year. Some weak plants require watering even in the second year. Thereafter, till the time of thinnings no special works are normally undertaken.

In Felling Series I and II, where the rotation is fixed at 15 years, the first and second thinnings are done in 5th and 10th year respectively. In Felling Series III, where the rotation is 20 years, the first and second thinnings are done in 7th and 14th year respectively. All the thinnings undertaken are mechanical. Markings for thinnings are done by March end and the stems marked for felling are sold standing during coupe sales.

9. The number of stems per acre available for extraction during final felling may be estimated as follows :—

(i) Planting @ 12 × 12 feet square in one acre .. .. 302 stems

(ii) Felling in the First Mechanical thinning .. .. 151 „

(iii) Felling in the Second Mechanical thinning .. .. 75 „

(iv) 10% casualties due to storms, erosion fungus, illicit cuttings, etc. 8 „

(v) Stand available for final felling .. .. .. 68 „

10. The expenditure incurred per acre and yield and revenue realized therefrom are given, for each felling series separately, in the Appendix I.

The expenditure varies annually due to necessitates for watering, depth of the ponds to be dug and fluctuating daily-wages.

The revenue realized depends considerably on the market conditions and the extent of competition among the bidders during coupe sales.

The yield varies due to the fact that the growth is not uniform in all places and the number of stems available for disposal varies considerably because of annual damage by natural and artificial injuries.

Revenue and expenditure figures per acre stand comparison as below :—

Felling Series	Total Revenue	Total expenditure	Surplus over Revenue
	Rs.	Rs.	Rs.
F.S. I	919 5 0	108 8 6	810 12 6
F.S. II	865 4 0	107 0 0	758 4 0
F.S. III	804 14 0	108 11 6	796 2 6
Total for 3 series ..	2,589 7 0	324 4 0	2,365 3 0
Average for each series	863 2 4	108 1 0	788 6 4

11. The coupes felled are replanted at the time of the next monsoon. In the case of felling coupes, the purchasers are required to erect a satisfactorily strong fence round the coupe, at their own cost.

The trees purchased by the contractors are felled and converted into billets 3 feet long by means of saws. The billets are piled into stacks of 9 × 4½ × 3 feet, each of which is considered as equal to one ton of 100 c.ft. (stack-green measurement). The *Casuarina* plantations being in close proximity to the sea, transport is very easy, so much so—the billets are mostly loaded into the vessels from the coupe directly. The felling and conversion charges are paid-for after stacking the billets and then the vessels are chartered and loaded directly.

The extraction and delivery charges of *Casuarina* fuel is given here as it may be of interest :—

(i) Felling, conversion into billets and stacking them neatly in the coupe itself .. .. Rs. 5/- per ton.

(ii) Loading the vessels .. .. .. Rs. 3/8/- per ton.

(iii) Freight to Bombay .. .. .. Rs. 28/- to Rs. 41/8/- per ton.

(iv) In the case of felling coupes erecting fence round the coupe from the branchwoods of felled *Casuarina* trees .. .. Rs. 4/- per 100 Rft.

The existing selling rate of *Casuarina* firewood in Bombay is Rs. 114/- per ton.

12. As per Revised Working Plan framed by Shri E. T. C. Vas, the first rotation has been completed in Felling Series I and II in 1949–50 and the second rotation is repeated from 1950–51. In felling series III, 18th coupe in the first rotation has been felled in 1952–53. The yield derived and revenue realized therefrom and cost on replacement and maintaining the plantations, since the introduction of this revised plan, i.e., from 1935–36 to 1951–52 are given in the following statement :—

Particulars	F.S. I		F.S. II		F.S. III	
	Yield c.ft.	Revenue Rs.	Yield c.ft.	Revenue Rs.	Yield c.ft.	Revenue Rs.
(i) From Trees planted prior to introduction of the existing plan						
(*a*) First and second special thinnings	231134·0	26711	73678·0	6851	181021·0	24906
(*b*) Wind fallen trees sold ..	93067·0	13301	16296·0	769	53175·0	8868
(*c*) Final fellings ..	812486·0	138667	216762·0	33676	840626·0	118209
TOTAL ..	1136687·0	178679	306736·0	41296	1074822·0	151983
(ii) From Trees planted after introduction of the existing plan						
(*a*) First thinning ..	71495·0	20562	13040·0	3366	73999·0	21854
(*b*) Second thinning	44005·0	26938	5100·0	1978	5700·0	2527
(*c*) Wind fallen trees	9549·0	3667	25·0	2	31633·0	10503
(*d*) Final felling ..	65800·0	31551	20100·0	8669	Not yet due	
TOTAL ..	190849·0	82718	38265·0	14015	111332·0	34884

Note :—Only two coupes of F.S. I and II have been felled in 2nd rotation.

Cost of raising and maintaining the plantation since the introduction of the existing plan, i.e., from 1936–37 to 1951-52 is as follows :—

F.S. I	F.S. II	F.S. III
Rs.	Rs.	Rs.
23,521	6,884	28,630

13. As this species grows fast and requires little attention, it can be planted in sandy *waste lands which are not useful for cultivation. Accordingly a propaganda was started to* increase area under *Casuarina* plantations, just after close of World War II. In response to this, many people came forward and availed of the opportunities offered to them. *Casuarina* seedlings were raise by the Forest Department in special nurseries and intending cultivators were supplied with seedlings free of cost. Even now many people plant *Casuarina* seedlings during the "Tree Planting" week.

Experiments are also in progress to see, if this species thrives well in inland areas without being watered. Accordingly some of the coupes of the fuel working plans, wherein teak could not be raised, were planted with *Casuarina* at 9 × 9 feet.

14. On the whole it can be seen that *Casuarina* is a species which can be cheaply raised and maintained and good quality firewood of high calorific value can be harvested in 15 to 20 years.

15. It can also be seen that while giving the state appreciable revenue from lands otherwise fit for no purpose, this species adds immense aesthetic value to the coast line, protects the land leeward from the devastating effects of winds and storms and binds the sand and minimizes wind-erosion and spread of sand on fields inland which would otherwise become sand-logged and rendered infertile. Thus plantations of this species benefit the State, the people and the individual too. One must, therefore, plant more *Casuarina* and cover every inch of barren sand if he wishes to protect his coco-nut gardens and fields along the coast-line from the fury of storms.

APPENDIX I

Average Statement of Expenditure, Revenue and Yield per acre from Casuarina plantations in Kanara Western Division, S.C., North Kanara District

Expenditure per acre

Items of Works	Average cost F.S. I	Average cost F.S. II	Average cost F.S. III
1	2	3	4
1. Clear-felling and fencing ..	Clear-felling coupes are sold standing with provision that the purchaser should create fence at his own cost.		
	RS. A. P.	RS. A. P.	RS. A. P.
2. On seed collection and nurseries ..	8 0 0	3 0 0	11 9 0
3. Preparing stakes and aligning ..	9 9 6	6 8 0	8 8 6
4. Planting, tying plants to stakes and replacing casualties ..	5 3 0	6 4 0	5 3 0
5. Digging water ponds and watering in the first year ..	58 12 0	55 12 0	55 4 0
6. Weeding and mulching	generally done by coupe *malis*		
7. Miscellaneous ..	2 0 0	3 0 0	3 8 0
TOTAL for the first season ..	83 8 6	74 8 0	84 0 6
Cost on watering in the second year	25 0 0	32 8 0	24 11 0
GRAND TOTAL ..	108 8 6	107 0 0	108 11 6

Revenue and Yield per acre

Particulars	Yield F.S. I	Yield F.S. II	Yield F.S. III	Revenue F.S. I	Revenue F.S. II	Revenue F.S. III
5	6	7	8	9	10	11
				RS. A. P.	RS. A. P.	RS. A. P.
First thinning	172·63	190·00	292·40	63 8 0	41 2 0	109 0 0
Second thinning	259·44	102·22	103·64	154 6 0	38 11 0	46 0 0
Final felling	1668·57	1604·44	1924·00	683 7 0	767 9 0	634 5 0
TOTAL ..	2100·64	1896·66	2320·04	901 5 0	847 6 0	789 5 0
2% Wind fallen dead dying and trees sold	42·00	38·00	46·00	18 0 0	16 14 0	15 9 0
GRAND TOTAL ..	2142·00	1934·66	2366·04	919 5 0	865 4 0	804 14 0

Note :—The above figures are averages of past three years.

AUSTRALIAN SCIENTISTS SEEK VALUABLE RAW MATERIALS FROM FOREST TREES

BY PETER DAVISON

Tough Australian hardwood trees, already valuable for their timber, are proving to be a valuable source of industrial raw materials.

Oils have been distilled from the leaves of the eucalyptus and tea (*Melalucas*) for many years and tannin extract is also being produced commercially from the wood of the West Australian Wandoo (*Eucalyptus redunca*).

Scientists at the New South Wales Forestry Commission's Division of Wood Technology have recently developed an industrial-type fibre from Australian stringybarks (particularly *Eucalyptus scabra*) and have discovered that one species of tea tree contains commercially useful cork in its bark.

One of the many tasks of scientists at the Division of Wood Technology in Sydney, the capital of New South Wales, is to find and develop new products from the saw-dust, bark and leaves of trees which normally are wasted.

There is world shortage of tanning materials and at present the Division is working in co-operation with the Australian Commonwealth Scientific and Industrial Research Organization (C.S.I.R.O.) to find new sources of tannin from Australian forests.

Australia imports from South Africa considerable quantities of wattle bark (a high source of tannin) and wattle bark extract, an ironical fact because the South African plantations of wattle were established with seed imported from Australia.

Although the wattle is a native of Australia, little wattle bark for tanning is produced because indiscriminate stripping of the bark from the tree in the past has reduced its numbers.

A tannin (kino) substance has now been found in the bark of the iron bark, an extremely hard timbered Eucalypt, but it is too early yet to know if the tannin can be extracted in commercial quantities.

Cork is another raw material which has been discovered in commercial quantities in Australian native trees. It is being produced by a Sydney manufacturer from the bark of certain broad and narrow leafed paper barked tea trees. The cork from the tea tree, unlike that obtained from the Spanish cork-oak, which is stripped from the tree in two inch slabs is in the form of flakelets. It is being used in the manufacture of mattresses, pillows and eider-downs.

Tea tree cork has a very low bulk density and it is an excellent insulating material. It has also been made up experimentally into gasket and insulating blocks. There is every possibility that cork obtained from the tea tree will eventually replace much of the cork now imported by Australia from Spain and Portugal.

The tea tree grows extensively throughout Australia and in large numbers. The tree is improved by regular stripping of the bark if the stripping is properly carried out.

Another potentially valuable source of cork is the bark of the several species of iron bark found in Australia. Cork from this source is similar in many respects to imported cork and methods of separating it from the bark are now being studied by scientists at the New South Wales Division of Wood Technology.

Strong fibres, superior in many respects to coco-nut fibre, have been produced experimentally by the Division's scientists. The fibres, which are obtained from the bark of a number of species of hardwoods particularly the stringy bark, have been used in place of sisal and coco-nut fibre in the manufacture of fibrous plaster sheets. The process of manufacture is cheap and the New South Wales Forestry Commission is confident that these hitherto unused barks will also provide industrially useful fibres for use in upholstery.

In contrast with most other countries, Australia's commercial forest resources are not large. That is why Australian scientists are trying to find a way to use as much as possible of every tree felled.

LIST OF ANIMALS SHOT IN U.P. ACCORDING TO RECENT ANNUAL REPORTS

Statement was kindly supplied by Shri N. N. Sen, I.F.S., Conservator of Forests, Western Circle, U.P.

All-India Serial No.	Species	Year and number of animals shot			
		1947–48	1948–49	1949–50	1950–51
1*a*	Tigres	41	55	56	67
1*b*	Tigress	29	26	26	27
2	Leopard or Panther	47	33	23	26
3	Wild cat	2	3	7	4
6	Hyena	11	8	3	6
8	Wild dog	3	1	4	..
9	Martens (pine)	..	6	4	2
12	Himalayan black bear ..	4	6	10	4
14	Sloth bear	5	13	6	11
28	*Ghoral*	3	1	..	4
29	Large antelope (*Nilgai* or blue bull)	17	..	12	43
30	Four-horned antelope ..	..	..	..	..
31	Black buck	1	9	1	..
32	Indian gazelle or *chinkara* ..	..	..	2	..
33	Barking deer or *Kakar* ..	19	23	25	39
35	Swamp deer or *gond* or *barasingha*	11	22	11	6
37	*Sambhar*	65	57	50	71
38	*Cheetal* or spotted deer or axis deer	160	147	214	197
39	Hog deer or *para*	38	25	9	14
43	Crocodile (*muggar*)	9	4	4	..
45	Python	..	2	1	..
46	Others—otter, pig and porcupines	355	284	225	268

STATEMENT OF ACCOUNT RECEIPTS AND PAYMENTS OF THE "INDIAN FORESTER" FOR THE CALENDAR YEAR 1952

Item No.	Receipts	Amount	Amount
		Rs. a. p.	Rs. a. p.
1	Opening balance as on 1-1-1952:—		
	(i) Face value of investments in custody with the Allahabad Bank Ltd., Dehra Dun:		
	3% Conversion Loan, 1946 ..	18,000 0 0	
	Stock Certificates of 1946 ..	1,400 0 0	
	3% 2nd Victory Loan 1959/61 ..	3,900 0 0	
	3% F.D. Loan, 1970/75 ..	6,000 0 0	
	P.O. 10-year Defence Saving Certificates ..	2,500 0 0	32,100 0 0
	(ii) Cash with Allahabad Bank Ltd., Dehra Dun as per Pass Book		6,216 15 5
	(iii) Cash in hand as per main cash book ..	352 0 0	
	Cash in hand as per main imprest cash book ..	10 4 6	362 4 6
	Postage and revenue stamps in hand		43 14 9
2	Subscriptions received during the year:		
	(i) Arrears up to 1950	546 13 0	
	(ii) For 1951 ..	1,840 15 0	
	(iii) For 1952 ..	13,011 8 0	
	(iv) Advance for 1953	5,173 11 0	20,572 15 0
3	Sale proceeds of stray issues of old and new copies and volumes of *Indian Forester*		591 0 0
4	Advertisements		3,819 0 0
5	Sale of reprints of articles ..		387 6 0
6	Interest on loans and deposits:		
	(i) On 10-year Defence Savings Certificates for Rs. 2,500 encashed on 24-5-52 ..	890 10 0	
	(ii) On other deposits	915 12 0	1,806 6 0
7	Government's share for block making		508 7 6
8	Recovery of postage through V.P. Parcels		86 14 9
9	Receipts from miscellaneous sources:		
	(i) From Director, Geodetic & Training Circle, Survey of India, Dehra Dun, on account of refund of cost of Capt. Masani's reprints ..	1,320 15 3	
	(ii) From other sources	27 5 0	1,348 4 3
10	Recovery of pay advance paid during 1951		90 0 0
	TOTAL .. Rs.		67,933 8 2

Item No.	Expenditure	Amount	Amount
		Rs. a. p.	Rs. a. p.
1	Establishment charges		2,640 0 0
2	Fees and allowances, etc. ..		25 0 0
3	Printing charges of *Indian Forester*:		
	(i) For 1951 issues ..	10,538 8 0	
	(ii) For 1949 issues from Aug. to Dec. 1952 ..	4,599 5 9	15,137 13 9
4	Cost of paper:		
	(i) For printing ..	877 13 0	
	(ii) For illustrations, etc.	612 8 0	1,490 5 0
5	Cost of half-tones and line blocks, etc.		980 10 6
6	Stationery and printing		280 5 0
7	Postage and telegrams		764 6 6
8	Bank charges		134 2 6
9	Income-tax and surcharge ..		235 14 0
10	Refund of subscriptions		346 1 0
11	Cost of store articles, their maintenance and repairs		4 8 0
12	Miscellaneous charges – freight conveyance binding, etc.		76 5 0
			22,115 7 3
13	Balance carried over on 31-12-52:—		
	(i) Face value of investments in custody with the Allahabad Bank Ltd., Dehra Dun:		
	3% Conversion Loan 1946 ..	18,300 0 0	
	Stock Certificates of 1946 ..	1,400 0 0	
	3% 2nd Victory Loan 1959/61 ..	3,900 0 0	
	3% F.D. Loan, 1970/75 ..	6,000 0 0	
	P.O. 12-year National Savings Certificates purchased on 24-5-52 on encashment of Defence Savings Certificates for Rs. 2,500 ..	3,390 0 0	32,990 0 0
	(ii) Cash with Allahabad Bank Ltd., Dehra Dun, as per Pass Book ..	15,193 12 11	
	Less cheques issued during Dec., 1952 but encashed during Jan., 1953 ..	2,509 11 3	12,684 1 8
	(iii) Cash in hand as per main cash book ..	98 4 0	
	Cash in hand as per imprest cash book with postage stamps	45 11 3	143 15 3
	TOTAL .. Rs.		67,933 8 2

(SD.). M. D. CHATURVEDI, I.F.S., *Chairman, Board of Management, The Indian Forester.*

(SD.). C. R. RANGANATHAN, I.F.S., *Vice-Chairman, Board of Management, The Indian Forester.*

(SD.). V. S. KRISHNASWAMY, I.F.S., *Honorary Editor, The Indian Forester.*

PROFIT AND LOSS ACCOUNT OF THE "INDIAN FORESTER" 1952

Item No.	RECEIPTS	Amount Rs. A. P.	Item No.	EXPENDITURE	Amount Rs. A. P.
1	Total subscriptions received ..	20,572 15 0	1	Establishment charges	2,640 0 0
2	Sale of stray issues	591 0 0	2	Fees and allowances	25 0 0
3	Advertisements	3,819 0 0	3	Printing charges	15,137 13 9
4	Sale of reprints	387 6 0	4	Cost of paper	1,490 5 0
5	Interest on loans and deposits ..	1,806 6 0	5	Cost of blocks	980 10 6
6	Government's share of cost of blocks	508 7 6	6	Stationery and printing	280 5 0
7	Recovery of postage by V.P.Ps. ..	86 14 9	7	Postage and telegrams	764 6 6
8	Recoveries from miscellaneous sources	1,348 4 3	8	Bank charges	134 2 6
9	Recovery of pay advance ..	90 0 0	9	Income-tax and surcharge ..	235 14 0
			10	Refund of subscriptions	346 1 0
			11	Cost of stores	4 8 0
			12	Miscellaneous expenses	76 5 0
					22,115 7 3
				Add subscription received in advance for 1953	5,173 11 0
				TOTAL .. Rs.	27,289 2 3
				Net Profit ..	1,921 3 3
	TOTAL .. Rs.	29,210 5 6		TOTAL .. Rs.	29,210 5 6

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EFFECTS OF GEOLOGICAL FORMATIONS ON THE DISTRIBUTION OF SAL (*SHOREA ROBUSTA*), IN MADHYA PRADESH FORESTS

BY M. A. WAHEED KHAN, B.SC. (HONS.) (BOM.), B.SC. (FOR.) (EDIN.)
Deputy Conservator of Forests

The first observations, on the relationship between the geological formations and the distribution of sal forests, were made by Middlemiss (1890) who pointed out that in the outer Himalayas, the distribution of sal is the limit of the Tertiary Zone. This, however, was a very broad generalization. Later on, Smythies (1919) observed in Naini Tal District that the geology of the tract is a predominant factor in the distribution of forest types. This geo-botanical contribution also, did not lead to any definite conclusions, especially as regards the distribution of sal forest. Therefore, in Madhya Pradesh, where a variety of geological formations converge, the results of these observations cannot be made applicable.

The monumental work of Troup – "The Silviculture of Indian Trees" – appeared in 1921, and it threw further light on this subject, especially with regards to the sal forests of Madhya Pradesh. The summary of his conclusions is as follows :

Forest Division	Locality	Rocks	Whether sal occurs on it or avoids it	Quality of sal
(1)	(2)	(3)	(4)	(5)
Bilaspur	..	Gneiss, Clayschist	Sal occurs and confines mainly to these rocks	Good
	Khannat Forest	Laterite and mixture of laterite and trap	Sal occurs moderately	Poor
	Chita – Pandaria area	Limestone	Sal occurs very sporadically	Very poor
	..	Sandstone, quartzite and pure trap	Sal avoids them	..
Jabalpur	..	Sandstone and clays	Sal occurs and confines mainly to these rocks	Poor
	..	Trap, porous sandstone, shale and limestone	Sal avoids them	..
Balaghat	Raigarh area	Mixture of laterite and trap	Sal occurs on it	Poor
	Raigarh area	Pure trap	Sal avoids it	..
	Baihar area	Gneiss	Sal occurs on it	Good
North Raipur	Sonakhan and Laun Ranges	Metamorphic and sub-metamorphic rocks	Sal occurs on them	Moderate
	Sonakhan Range	Cuddapah sandstone and limestone	Sal avoids them	..
South Raipur	Sal Ranges	Metamorphic rocks	Sal occurs on them	Good

The sum total of these conclusions is that sal occurs mainly on metamorphic and sub-metamorphic rocks and occasionally on sandstones, clays, laterite, mixture of laterite and trap, and limestone. And it usually avoids pure trap, shales, quartzites, limestones and

porous sandstones. This is a fair advancement in the geo-botanical knowledge of sal forest and indicates a faint correlationship. But, however, it fails to explain the patch mixture of sal and mixed forests, occurring on the same general geological formation.

Champion (1933) carried this study still further and conclusively determined that the underlying rock is of small importance, specially when the distribution of sal is correlated with the depth, aeration and moisture retaining properties of soil. Thus a given rock may generally carry a certain type of sal forest, the same type may also occur on a wide range of different rocks. Therefore, geological formation comes into picture only as a secondary consideration. This is particularly the case in the Central Indian region. The faint correlation which he observed between the occurrence of various geological formations and types of sal forests, occurring in Madhya Pradesh, is as follows :

Sal type	Quality of sal	Associated rocks and soils	Forest Divisions where found
(1)	(2)	(3)	(4)
A3. Dry Peninsular sal ..	IV	Crystalline rocks with dry shallow soil	Bilaspur, North Raipur and South Raipur
B2. Moist Peninsular sal ..	III–II	Crystalline rocks with yellow soils	In all sal divisions
B2*a*. Supkhar sal ..	IV	Laterite, trap and crystalline rocks	Balaghat, Mandla, Bilaspur, Jabalpur and Hoshangabad
B2*b*. South Raipur sal ..	III	Crystalline rocks with yellow loam soils	South Raipur, Balaghat, Mandla and Bilaspur
B2*c*. Singhbhum valley sal ..	II	Wash from crystalline rocks – a deep loam	Bilaspur, Mandla, North Raipur and South Raipur
B2 APP. Frosty valley sal ..	III–IV	Alluvial, often black soil	Balaghat, Mandla and Bilaspur

Note :—These quality classes are—I = over 110 feet, II = 110–90 feet, III = 90–70 feet and IV = under 70 feet.

This shows that the best sal occurs on wash from crystalline rocks where the soil is a deep loam. Good quality sal occurs on crystalline rocks which produce moderately deep yellow soils. The moderate quality sal occurs on crystalline rocks producing yellow loam soils. The poor quality sal occurs on alluvium, often turning into black soils. The poorest sal occurs on laterite, trap and crystalline rocks producing only dry shallow soils. These observations, again, do not establish the firm geo-botanical correlationship of sal.

Mooney (1947) duly considered the chief drawbacks of the previous observations and he studied the nature of each type of rock prior to establishing any definite correlation. He concluded that sal occurs primarily on acidic rocks and if by erosion the acidic top-soil is washed away leaving behind the basic rock stratum, sal gradually disappears from the locality. This observation laid the foundation for the systematic observations to be made in right direction.

The main emphasis is put forth on the nature of soil in which the trees take their roots and not on the underlying rock. Thus it duly took into account the accepted pedological principle that the same type of soil may be formed from a number of varied rocks, under the uniform climatic conditions. This explains to some extent, the occurrence of sal on varied geological formations in Madhya Pradesh.

Further studies on this subject were made by Puri (1950), in Dehra Dun valley. He showed that better type of sal occurs on the Siwalik clay, which is ferruginous and has low pH value. On the conglomerate rock, on the other hand, sal forms a low percentage in the

tree canopy. Thus he correlated the occurrence of various plant communities with structural geology and the pH values of different soils. It is, therefore, a decided improvement on the previous observations but still the results are more or less tentative and their applicability is restricted.

Sathe (1951) studied this correlation in the sal forests of Madhya Pradesh and his results indicate that good quality sal community occurs on light sandy rocks, the pH values of which lie between 5·8–6·8. Poor types of sal, usually M.P. III (50′–70′) and IV (below 50′) qualities, occur on hard sandstones, quartzites, laterites, etc., the pH values of which vary between 7·0–8·0. On granites, calcarious tuffas, slates, etc., forest communities are of miscellaneous species, with or without bamboos. These rocks have a pH value, mostly about 7. These results would have been of immense value but unfortunately there seem to be some obvious mistakes in the identification of rocks.

This review of the past observations and researches indicates that no definite correlation has yet been established between the occurrence of various geological formations and the distribution of sal forest. To fill up this lacuna it was, therefore, decided to study this problem in South Raipur forests. Harlow (1924) while preparing the working plan of this area remarked – "The geology of this tract has never been properly examined......particularly in the absence of any detailed knowledge of the geology and soils of the neighbourhood, no attempt has been possible to work out the ecology of sal" – The geology of the sal ranges (South Raipur) was originally mapped by Shri P. N. Bose, in 1883–84. No further geological mapping has been done, since then. Bose concluded that this tract carries predominantly gneisses, sandstones and quartzites. The massive granitoid gneisses form the major rock formations and cover almost entire area of the Sal Ranges, except along the northern border of Nagri and Birguri ranges where sandstone occurs, either purely or intermixed with metamorphic rocks. The lesser metamorphic formations found in this region are, schistose rocks in the southern portions of Risgaon and Sitanadi ranges, granites in the hills north of Sihawa and also along Jeypore boundary, coarse-grained granite in the Boirgaon forest near Sondul River, and arkose in the hills east of Belarbahra. The occurrence of sal forest in relation to these rocks was studied and it is noticed that even on the same rock, the coverage of sal forest is not continuous and patches of mixed forest are mostly interspersed. At places, these mixed forests are invaded with progressing advance growth of sal, but it is not a general rule. It was, therefore, decided to study these geological formations more thoroughly and to determine if really any definite correlation exists. With this end in view, 52 rock samples were collected from all over the area, representing all the geological formations and also the apparent variations of the same rock. Detailed notes of forests were also made, from where these rock specimens were collected. The Geological Survey of India, very kindly made petrographic examination of these specimens. The results obtained are tabulated below :—

Main rock formations	Variations	Petrographic composition	Description of sal forest occurring on it		
			Quality (M.P.)	Percentage of sal in the crop %	Condition of sal reproduction
(1)	(2)	(3)	(4)	(5)	(6)
1. Granites	1. Light grey granites	Quartz (fine to coarse-grained), felspar (*altered to calcite*, sericite and zoisite), biotite, chlorite, sphene, apatite and ore minerals	III, but occasionally absent	50–70	Advance growth occurs, but *it is* mostly patchy, sparse and remains unestablished for a long period

(contd.)

Main rock formations	Variations	Petrographic composition	Description of sal forest occurring on it		
			Quality (M.P.)	Percentage of sal in the crop %	Condition of sal reproduction
(1)	(2)	(3)	(4)	(5)	(6)
1. Granites (*contd.*)	2. Pink granites	Quartz (sometimes highly crushed and granulated), felspar (mostly altered, saussseritized and sericitised), biotite (in small to moderate quantities), chlorite, muscovite (little), microcline (partly Kaolinised), epidote (very common in certain forms), and opaque grains	II, but absent on shallow soils and outcrops	50–90	Advance growth is sufficient and mostly established but stagnant under the heavy top canopy
	3. Graphic granite	Microcline, quartz	III/II	40–60	Advance growth occurs but it is sparse and whippy
	4. Coarse biotite granite	Flespar (sausseritised and sericitised), epidote, calcite, opaque grains, biotite and chlorite	III/II	40–70	Do.
2. Schists	5. Hornblende schist	Blue-green hornblende, quartz (large grains), apatite (profuse inclusions), sphene and chlorite	II/I but occasionally absent	60–80	Advance growth plentiful and established
	6. Amphibole quartz schist	Quartz, plagioclase, felspar (highly sausseritised), amphibole, chlorite, epidote (some) and ore minerals	II	45–75	Fair amount of advance growth occurs and is mostly established
3. Quartzites	7. Quartzite	Quartz (a variety of form has been noticed; some have equigranular grains with some effects of crushing, others have closely packed grains, in some they are brecciated, in some others they are elongated and packed. Medium grained, compact and closely packed specimens are, by far the commonest), Epidote (it occurs as lenticular bands of fine granules in some, in others it occupies lenticular veins or fracture zones. In some varieties it is found abundantly), Felspar (although it occurs, it is in very limited quantity and usually altered to some extent or completely kaolinised), Tourmaline (it occurs as rounded grains occasionally), Chlorite (it occurs occasionally but abundantly), Chert (a few grains in some specimens), Biotite (little), argillaceous matter (some), mica flakes (occasionally), ore minerals and opaque grains.	IV/III or absent	20 or less	Advance growth practically absent

(*contd.*)

Main rock formations	Variations	Petrographic composition	Description of sal forest occurring on it		
			Quality (M.P.)	Percentage of sal in the crop %	Condition of sal reproduction
(1)	(2)	(3)	(4)	(5)	(6)
3. Quartzites	8. Brecciated quartzite	Quartz (crushed and recemented) microcline (altered)	III or III/IV	5–25	Do.
	9. Felspathic quartzite	Felspar, quartz, epidote (small), chlorite (small), biotite (small), zoisite and microcline	III but occasionally absent	15–45	Advance growth very sparse and unestablished
	10. Ferruginous quartzite	Quartz • argillaceous material jasper grains hematite (abundant), limonite (abundant) opaque mineral	III/IV or absent	15–20	Do.
	11. Compact quartzite	Besides quartz it includes some ferruginous material	III/IV or absent	Scattered sal	Absent
4. Quartz deposits	12. Vein quartz	Quartz (very inequigranular, angular, interlocking grains), zoisite (granules along cracks)	Sal absent	..	..
	13. Brecciated vein quartz	Quartz (elongated grains)	Do.	..	..
	14. Chert and Micro-crystalline quartz	Quartz, chert	Do.	..	..
5. Limestone	15. Fine-grained dark-grey limestone	Calcite and dolomite	Do.	..	..
	16. Impure ferruginous limestone	Calcite and dolomite with some ferruginous impurities	IV	Scattered sal	Absent
6. Banded quartz-magnetite rock	17. Banded quartz-magnetite	Quartz, cummingtonite, apatite, chlorite and ore minerals	Sal absent	..	..
7. Epidote rock	18. Epidote rock	Epidote (medium grained), quartz, felspar, biotite	III/IV	10 or much less	Very sparse and unestablished advance growth present
8. Limonite-quartz-microcline aggregates	19. Limonite-quartz-microcline aggregates	Limonite, quartz, and microcline	III/IV	15 or practically absent	Do.
9. Quartz-felspar-epidote rock	20. Quartz-felspar-epidote rock	Felspar (fairly altered and sericitised), epidote (granular quartz, calcite) (some)	IV or absent	Up to 10	Absent

(*contd.*)

Main rock formations	Variations	Petrographic composition	Description of sal forest occurring on it		
			Quality (M.P.)	Percentage of sal in the crop %	Condition of sal reproduction
(1)	(2)	(3)	(4)	(5)	(6)
10. Quartz felspar hornblende rock	21. Quartz felspar hornblende rock	Felspar (Sericitised), quartz, biotite (small flakes forming lenticular aggregates), blue-green hornblende (large plates), apatite, sphene, ore minerals	II	60–85	Advance growth present and established but patchy
11. Amphibolites	22. Amphibolites	Blue-green hornblende, plagioclase (highly saussuritised), felspar, pale-green amphibole, zoisite and opaque grains.	III	20–50	Advance growth plentiful but mostly unestablished
12. Sandstone	23. Argillaceous sandstone	Quartz grains in argillaceous matrix, biotite, chlorite and opaque grains	III/IV or occasionally absent	Only scattered	Some advance growth but unestablished
13. Arkose	24. Arkose	Quartz, felspar, argillaceous material, chloritic matter, tourmaline (occasional grains), opaque grains	III	40–55	Advance growth patchy and established
14. Conglomerate	25. Conglomerate	Quartz (fairly rounded grains), felspar, matrix of ferruginous and fine-grained quartzose material	II or occasionally absent	10–25	Advance growth occasionally absent
15. Biotite gneiss	26. Sheared biotite gneiss	Felspar (broken grains), quartz (lenticular granules)	III/II	30–60	Very sparse but established advance growth
16. Breccia	27. Breccia	Felspar (large grains), quartz (crushed), cherty and micaceons material	III/IV or absent	Scattered	Very little unestablished advance growth only

Note.—M.P. quality classes are—I = over 90 feet, II = 70–90 feet, III = 50–70 feet and IV = below 50 feet.

The indications of this investigation are :—

(*a*) Sal may or may not occur on the same type of rock.

(*b*) No particular rock mineral or minerals, may be regarded as controlling the occurrence of sal. However, the rocks containing greater proportion of quartz or calcite and dolomite, usually carry no sal or only poor sal. Thus sal is completely absent from deposits of vein quartz, brecciated vein quartz, Chert and micro-crystalline quartz, fine-grained dark grey limestone and banded quartz-magnetite. Frequently sal also avoids quartzite, ferruginous quartzite, compact quartzite, quartz-felspar-epidote rock and breccia. Occasionally sal is also absent from light grey grantite, pink grantite

hornblende-schist, felspathic quartzite, argillaceous sandstone and conglomerate. The rocks which usually carry sal crop are graphic granite, coarse biotite granite, amphibole-quartz-schist, brecciated quartzite, impure ferruginous limestone, epidote rock, limonite-quartz-microcline aggregates, quartz-felspar-hornblende rock, amphibolite, arkose and sheared biotite gneiss.

(c) There does not seem to be any definite correlation between the sal quality and sal-bearing rocks. The following generalization may, however, be drawn.

M.P. I/II Quality—Hornblende-schist.

M.P. II Quality—Pink granite, amphibole-quartz-schist, and quartz-felspar hornblende rock.

M.P. II/III Quality—Graphic granite, coarse biotite granite and sheared biotite gneiss.

M.P. III Quality—Light grey granite, brecciated quartzite, felspathic quartzite, amphibolite, arkose and conglomerate.

M.P. III/IV Quality—Quartzite, brecciated quartzite, ferruginous quartzite, compact quartzite, epidote rock, limonite-quartz-microcline aggregates, argillaceous sandstone and breccia.

M.P. IV Quality—Impure ferruginous limestone and quartz-felspar-epidote rock.

This analysis further indicates that the high quality sal is associated to some extent with the presence of hornblende, in underlying rock. Occurrence of hornblende with preponderance of felspar indicates medium quality sal and abundance of quartz and chert indicates poor type of sal.

(d) Even the percentage of sal trees in the sal forest is not definitely correlated with the type of underlying rock. The following is the broad generalization :

Only scattered sal (less than 5%)—Compact quartzite, impure ferruginous limestone, argillaceous sandstone and breccia.

Percentage of sal, 5–20%—Epidote rock, quartz-felspar-hornblende rock, limonite-quartz-microcline aggregates, ferruginous quartzite and quartzite.

Percentage of sal, 20–50%—Brecciated quartzite, conglomerate, felspathic quartzite, and amphibolite.

Percentage of sal, 50–70%—Arkose, sheared biotite gneiss, graphic granite, coarse biotite granite and light grey granite.

Percentage of sal, 70–90%—Amphibole-quartz-schist, hornblende schist, quartz-felspar-hornblende rock and pink granite.

This also indicates that higher the quality of sal, greater the percentage of sal in the crop and is faintly correlated with the occurrence of hornblende and felspar, in the underlying rock.

(e) The occurrence of sal advance growth and the degree of its establishment is only faintly correlated with the rocks containing fair amounts of hornblende and felspar.

The above indications suggest no definite correlation between the underlying rocks or their mineral constituents and the occurrence of sal forest, at least under the South Raipur conditions. The faint correlation, as it exists, is only of a secondary nature. Therefore, it may conclusively be said now that the distribution of sal is primarily dependent on factors other than local geology, and if, at all, the local geology does play any part it is only secondary

in behaviour. It has, however, been observed that the general distribution of sal is governed mainly by climate; and rainfall is, by far, the most potent factor. The range of absolute temperatures also becomes a limiting factor in certain localities, but in Madhya Pradesh where such a range is not appreciably wide, temperature does not seem to influence the distribution of sal. The normal rainfall in various districts of Madhya Pradesh is as follows :—

District	Early Monsoon (June to Aug.)		Late Monsoon (Sept. to Nov.)		Cold weather (Dec. to Feb.)		Hot weather (March to May)		Annual total		M.P. quality of sal forest	Forest Division included
	a	b	a	b	a	b	a	b	a	b		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
					Sal-bearing Districts							
Bastar (Jagdalpur)	41·08	50	15·88	21	1·63	3	4·67	10	63·26	84	I and over	North Bastar, South Bastar and Kanker.
Raipur ..	38·09	44	10·77	13	1·38	2	2·13	5	52·37	64	I to II	North Raipur, South Raipur and Bindranawagarh.
Mandla ..	42·00	50	10·11	12	2·38	3	2·12	5	56·61	70	II/III	Mandla (*Karanjia* range in Bilaspur).
Balaghat ..	49·92	53	11·75	13	1·70	2	1·84	4	65·21	72	II/III	Balaghat.
Bilaspur ..	36·66	45	10·30	16	1·76	3	2·20	5	50·92	69	II/III	North Bilaspur and Bilaspur.
Durg ..	34·87	36	10·41	13	1·48	3	1·90	4	48·66	56	II/III	Durg (sal in Kawardha area).
Jabalpur ..	43·16	48	10·95	10	1·97	3	1·41	3	57·49	64	III/IV	Jabalpur (eastern portion).
Surguja (Ambikapur)	40·42	49	11·04	15	2·58	5	1·99	4	56·03	73	III/IV to V	Surguja and Korea
Raigarh ..	47·87	49	11·75	15	1·59	3	1·86	4	63·07	71	III/IV to V	Raigarh and Jeshpur.
					Districts with sal out-liers							
Hoshangabad	38·11	44	10·62	10	1·27	2	0·76	2	50·76	58	..	Near Pachmarhi. There are some in North Raipur and Bastar.
					Non-sal-bearing adjoining Districts							
Sagar (Damoh)	36·34	39	9·60	11	1·54	2	0·90	2	48·38	54	..	
Chhindwara ..	27·81	33	10·42	13	2·07	3	1·65	4	41·95	53	..	
Bhandara ..	40·08	45	10·87	15	1·79	2	1·95	4	54·69	66	..	
Chanda ..	35·70	40	11·38	14	1·24	1	3·10	5	51·42	60	..	

Note.—a = Total rainfall in inches, and
b = Total number of rainy days.

This rainfall table indicates, as follows :—

(*i*) Sal forests occur in areas where the total annual rainfall is well over 55 inches. The only exceptions seem to be Raipur, Bilaspur and Durg. This is, however, explainable. All these three stations are actually far away from the sal-bearing areas, and thus they do not represent the actual rainfall of those tracts. The main sal-bearing areas of Raipur District are the sal ranges in South Raipur Division, the southern half of Bindranawagarh Division, adjoining the Sal Ranges and the vast out-liers of North Raipur Division, in Sonakhan and South Laun ranges, and in Phuljhar, Pithora, Deori and Bilaigarh areas. Raipur is 40 miles away from these tracts. Similar is the case with Bilaspur. It is nearly 30 miles away from the real sal-bearing zone of Bilaspur District. In Durg District, sal confines to Kawardha area which is also far away from it. In all these sal areas total annual rainfall is definitely far over 55 inches and in Sitanadi and Risgaon ranges of South Raipur Division, it may even exceed 70 inches. The actual figures of rainfall can, however, be collected after establishing rain-gauge stations all over the sal-bearing areas.

(*ii*) The sal out-lier in Hoshangabad District lies close to Pachmarhi, where the total annual rainfall ranges between 60 and 70 inches.

(*iii*) In the entire sal-bearing Zone of Madhya Pradesh, total annual rainfall, coupled with the effects of local geology, influences the quality of sal. Thus Bastar and Raigarh, although they receive practically equal amounts of rainfall annually, the former carries the best sal, as the local geological formations are granites, and the latter almost the poorest on Cuddapahs and lower Gondwana formations.

(*iv*) Even in the same district or forest division where the average annual rainfall is over 55 inches, sal stops short or degrades unduly in quality, as soon the total rainfall runs below this limit, even though, there may be the same geological formation in the neighbourhood.

(*v*) The total rainfall during the year and its spread over longer or shorter period seem to influence the quality of sal in the locality. The general rule is that, higher the total rainfall and its spread over a greater number of days during the year, causes sal to attain better quality.

(*vi*) The total rainfall, and its spread, during the monsoon (June to November) does not seem to influence the quality of sal. It has practically the same effect as the total annual rainfall.

(*vii*) The rainfall during cold weather is negligible and does not influence the quality of sal.

(*viii*) Total rainfall and its distribution during the hot weather (March to May) is a limiting factor. During this period new flush of sal leaves appears and the young leaves are quite energetic in transpiration. A long dry period, therefore, unduly affects growth, but an adequate amount of rainfall stimulates it. Thus the Bastar District which receives maximum rainfall of 4·67 inches during this period and is spread over a maximum period of 10 days, carries the finest sal forests of Madhya Pradesh. Raipur, Mandla and Bilaspur Districts which receive 2·12 to 2·20 inches of rainfall during this period and the spread is normally over 5 days, the sal quality varies between M.P. I to II/III. In rest of the areas where summer rains are rather restricted, the quality of sal appreciably dwindles down.

It is, therefore, conclusive that within the sal zone itself, in Madhya Pradesh, *the distribution of sal is governed by soil moisture.* Where soil moisture is even just normal, sal flourishes, irrespective of the fact whether such soils are derived from one geological formation or the other. When it becomes either excessive or too limited to create dry conditions, sal is usually absent and if it occurs, it is of very poor type and also the percentage of sal trees in the stand is very low. Thus the soils derived from limestones, trap, and sandstones are very deficient in soil moisture and usually do not carry sal. Where decomposed laterite gets mixed up with these soils, their moisture retentive power is improved, and sal appears. This amount of moisture, however, is not sufficient and the sal crop is only of a poor quality. Excessive moisture causes bad soil aeration and, therefore, sal avoids it. Once the drainage is improved in such areas, fine sal stands may appear. Hole (1914) observed this pertinent factor of soil moisture and showed that sal seed germinates very successfully even in pure sand provided it is sufficiently moist. But the seedlings die of drought if the soil water content falls to 3 per cent in sand or sandy loam and to 10 per cent in loam. Later on, Troup (1921) generalized this remark by saying that the most favourable soil for the growth of sal is a well-drained moist deep sandy loam with good subsoil drainage.

Soil moisture is controlled by topography, aspect and physical and chemical properties of the soil itself. The main soil properties which influence soil moisture are hygroscopic constituents of the soil, soil colloids, depth of the soil and soil texture.

Topography affects mainly gravitational water in the soil. Thus the soils on steep slopes are thoroughly drained off and have comparatively a low percentage of soil water, whereas in depressions, gravitational water tends to accumulate and creates bad soil aeration. On moderate slopes and on undulating country-side, soil moisture is just sufficient with adequate drainage. Thus sal confines to low undulating hills, lower reaches of steep hill slopes, and very frequently flat stretches of land where drainage is good. In pockets, on steep slopes, where water gets a chance for accumulation, sal occurs only as a sporadic constituent of the crop.

In Madhya Pradesh, where rainfall is just sufficient for the optimum growth of sal, aspect plays an important role in the distribution of sal. It affects hygroscopic water in the soil. Southern and eastern aspects are hot and the soils on these aspects are consequently drier. On these soils, sal is either entirely absent or only poorly grown. Usually the northern and north-western aspects carry the best sal. In a hill-and-dale country-side like that of North Bilaspur Division the effect of aspect is most pronounced.

Soil colloids play a very important part on the water-holding capacity of soils. Every type of soil contains a varying amount of colloidal matter which imbibes water and thus these colloidal particles are responsible for the enhanced tendency of soil particles to retain water. This property is of inestimable importance in soils of medium and light texture but it also becomes a great inconvenience when a soil contains a very high percentage of colloidal clay. These colloids also play an important part in the retention of bases, such as lime, potash, etc., in the soil, and indirectly of certain acids, notably phosphoric acid.

Champion (1933) has observed that the depth of soil may equally be influential in the distribution of forest types and this effect is particularly marked in peninsular India. Under South Raipur conditions it has been observed that the quality and density of sal stands and also the preponderance of sal advance growth improves directly and proportionately with the increase in depth of the soil-cap, provided other growth factors are constant. Deep soils with unimpeded drainage carry the best sal, truncated soil profiles the poorest and the soils of moderate depth with fair drainage, the average quality sal forest. It, therefore, suggests that the deep soils hold greater amount of total soil-water than the thin ones, and in the case of

truncated soils, the exposed subsoil has a much less water-holding capacity. Therefore, the distribution and quality of sal is directly correlated with soil moisture.

The moisture-holding capacity of soil is also dependent on soil texture. Comber (1945) reports the following figures :—

Moisture-holding capacity under field conditions

Depth of soil	Sandy *loam* per cent	Clay *loam* per cent	Humus soil per cent
First foot	17·65	22·67	44·72
Second foot	14·59	19·78	21·24
Third foot	10·69	18·16	21·29

These figures clearly indicate that greater the proportion of clayey and humic matter in the soil, greater is its moisture-holding capacity. Therefore, the loamy and silty soils which retain fair amount of moisture, mainly carry sal. Soil texture is affected by soil structure and further, the amount of water held by various texturally different soils varies enormously with the height of the soil above the water-table.

Under South Raipur conditions, it has been determined that the density, quality and reproductive capacity of sal forest are correlated with textural soil classes. Silty clay loams occurring along Sondul River, carry some of the finest sal stands of that Division. Sandy clay loam deposits occur along most of the water courses but they are rather drier and do not carry sal. Humified deep sandy loams are found on undulating low hills and flat grounds, and they generally carry the good quality sal. Wherever, the proportion of clay unduly increases, sal gets stunted and unhealthy and when the proportion of arenaceous material increases, sal is either absent or occurs only as a sporadic constituent. Soil is a dynamic system and in the neighbourhood of sal forest, as a result of gradual increase of humic or argillaceous matter, soil ameliorates, and sal also starts invading it gradually.

Conclusively, therefore, it may be said that the distribution of sal in the natural sal region of Madhya Pradesh, is correlated directly and primarily with the soil moisture. Geology comes into play only as a secondary factor. To some extent, the soils derived from different rocks have different water-holding capacities. Effects of topography and aspect may also be treated at par with the local geology, so far as they are concerned with the distribution of sal.

As regards the future trend of researches in this respect, it may be suggested to continue further the work of Griffith and Gupta (1948). They have already drawn the following tentative conclusions :—

(*i*) A sandy loam texture in soil is most suitable for sal.

(*ii*) Sal tolerates fairly acidic conditions (pH 4·5–5·5 in the subsoil).

(*iii*) A maximum amount of organic matter, to the extent present in sal soils (about 2 per cent) is not detrimental to sal regeneration.

(*iv*) A high ratio of CO_2/O_2 in soil solution appears to affect the regeneration adversely.

For Madhya Pradesh sal soils, this trend of research needs a little modification. It is a well-known fact that the soils that are formed in similar environments belong to the same

type but they may not have similar characteristics since they may, at any given moment, be at very different stages of development. The rate at which a soil type develops, and the intermediate stages through which it passes to reach its full development are largely determined by the properties of the parent rock. For instance, in an area where the effect of climate is to cause leaching of the soil constituents, it will proceed at a faster pace in a permeable sand than in a heavy clay. But where the climate tends to augment soil acidity, a granite soil reaches its full development much sooner than, and by quite different stages from a limestone soil. But within any single climatic zone, the climate will always act in a direction tending to produce the climatic climax, and a soil type characteristic of the climate.

Thus in a mature soil, during the process of evolution, many of the original properties of the parent rock material are modified or eliminated. In immature soils, however, the geological characteristics are rather pronounced. Thus the future researches in Madhya Pradesh should aim to solve the following problems, with respect to sal soils :—

(*i*) Collection of rainfall data from all over the sal-bearing areas.

(*ii*) Determination of mature and immature soils, under sal forest, particularly on each geological formation separately. The method to be adopted may be the one as designed by Ellis (1952). A pit is dug sufficiently deep to reach the hard parent rock and the analysis of not only the various soil horizons at regular short intervals is made but also of the partially disintegrated rock and the hard parent substratum, and then the differences are determined and correlated.

(*iii*) Textural classification of sal soils.

(*iv*) The maximum water capacity and the moisture-holding capacity of all the sal soils, particularly in different horizons of the profile.

(*v*) Variation of pH in various layers of sal soil types.

(*vi*) The minerals absorbed from various sal soils and assimilated by sal.

(*vii*) Measurements of water-table in all sal soils.

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INDIGENOUS CELLULOSIC RAW MATERIALS FOR THE PRODUCTION OF PULP, PAPER AND BOARD

PART XV.—CHEMICAL PULPS AND WRITING AND PRINTING PAPERS FROM *ALBIZZIA STIPULATA*, BOIVIN

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SUMMARY

Laboratory experiments on the production of chemical pulps by the sulphate process from the wood of *Albizzia stipulata* are described. The wood was obtained from forests of Bihar. Results of four pilot plant experiments on the preparation of writing and printing papers from this wood are also included. This investigation has shown that chemical pulps in satisfactory yields can be prepared from this wood. The whiteness of the bleached pulps was good. Although the average fibre length of the pulps was only 1·02 mm., writing and printing papers made on the pilot plant from the furnish containing entirely the pulp from this wood were characterized by good strength properties. The formation of the papers was satisfactory. Two samples of papers – one writing and the other printing – are appended in this bulletin.

INTRODUCTION

Albizzia stipulata, Boivin, is a large, deciduous, fast growing tree. It is known as *siran* in Hindi. It belongs to the *siris* family. The wood is soft. The sapwood is white but the heartwood is brown. This species grows in the sub-Himalayan tract from the Indus eastwards, ascending to 4,000 feet, Bihar, Bengal, South India, the Andamans and the Nicobars. It is also found in Burma and the moist low parts of Ceylon[1]. Because the wood is soft and the sapwood, which forms a large portion of tree, is white, an investigation was undertaken on the production of groundwood pulp for newsprint from this wood. It was also thought desirable to find out the advantages of making chemical pulps from this wood. The results of the latter investigation are described in this bulletin.

THE RAW MATERIAL

Eight logs, 16–17 feet in length and 15–27 inches in diameter, were obtained from Samta Range, Saranda Division, Bihar. These logs were cut from trees of about 30 years' growth. The heartwood was coloured reddish-brown and sapwood white. The logs were received without bark. The moisture content of the wood as received was 20%. The logs were chipped in the factory chipper and screened on the factory screen. The screened chips were used for the laboratory and pilot plant experiments.

PROXIMATE CHEMICAL ANALYSIS

The chips were reduced to dust in the usual way. The dust passing through 60 mesh and retained on 80 mesh was used for the proximate chemical analysis employing the TAPPI standard methods. The results of the proximate analysis are recorded in Table I.

TABLE I

Proximate chemical analysis of the wood of Albizzia stipulata

		% on the oven-dry basis except moisture
1.	Moisture	6·42
2.	Ash	0·63
3.	Cold water solubility	4·38
4.	Hot water solubility	8·12
5.	1% NaOH solubility	17·71
6.	10% KOH solubility	30·75
7.	Ether solubility	0·89
8.	Alcohol-benzene solubility	1·51
9.	Pentosans	18·28
10.	Lignin	23·71
11.	Cellulose (Cross and Bevan)	60·17

From these results it will be seen that the cellulose content of this wood is quite high. This indicates that it is a suitable raw material for the production of paper pulp from the point of view of the yield.

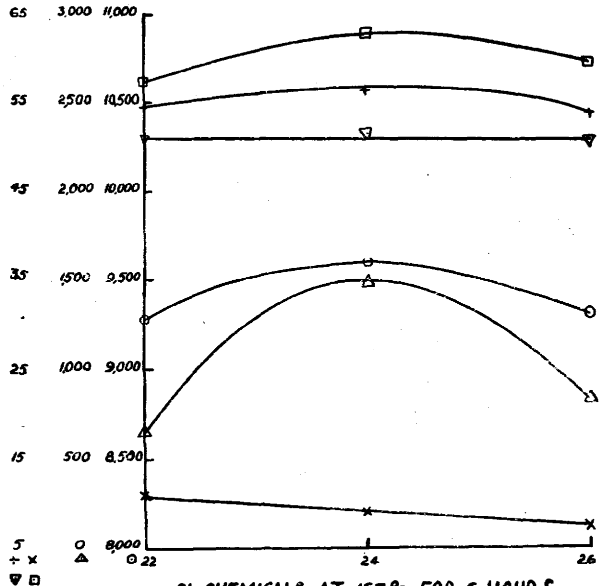
FIBRE DIMENSIONS

Bleached pulp prepared by the sulphate process using 24% of chemicals (on the oven-dry weight of the material) in a concentration of 48 g./litre at 162°C. for 6 hours was used. The measurements of the length and diameter of the fibres were made by the procedures described earlier[2, 3]. The average fibre length was found to be 1·02 mm., the minimum and maximum values being 0·64 mm. and 1·63 mm. respectively. The fibre diameter varied from 0·007 mm. to 0·043 mm., the average value being 0·027 mm. The fibre length distribution is given in Table II and the fibre diameter distribution in Table III. The ratio of the average fibre length to diameter was 38 : 1. As is usual with hardwoods, the value of this ratio is small compared to pulps from coniferous woods, bamboo and grasses.

TABLE II

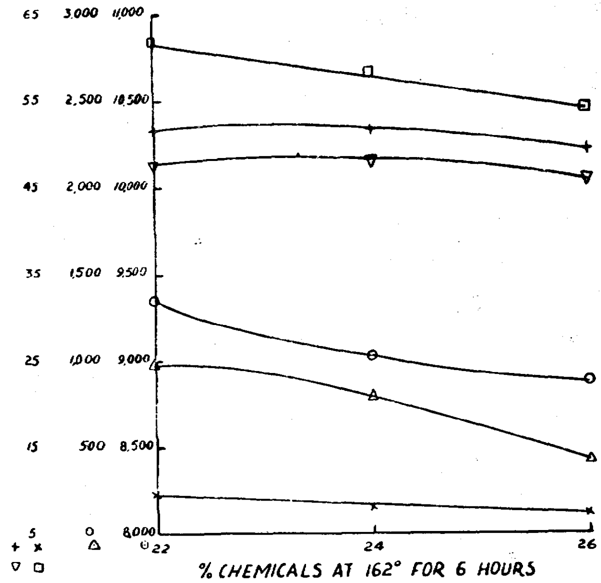
Fibre length distribution

Length of fibres mm.	Number of fibres	% of fibres
From 0·6 to 0·8	41	20·5
From 0·8 to 1·0	43	21·5
From 1·0 to 1·2	75	37·5
From 1·2 to 1·4	31	15·5
From 1·4 to 1·6	10	5·0
TOTAL	200	100·0



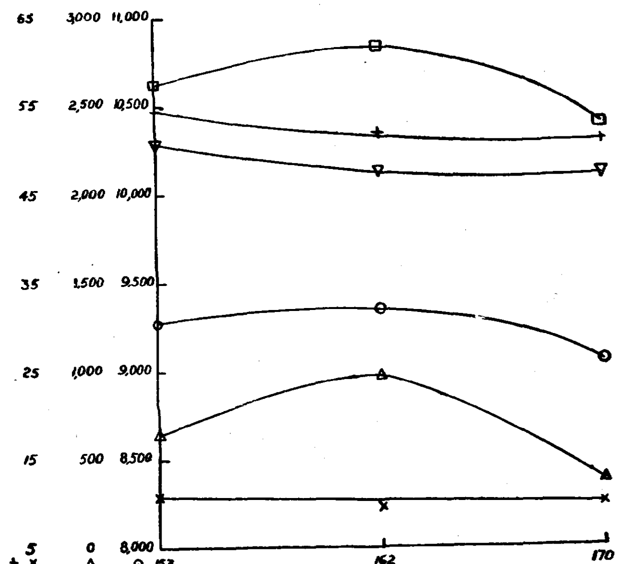
% CHEMICALS AT 153°C. FOR 6 HOURS

FIG. 1.



% CHEMICALS AT 162° FOR 6 HOURS

FIG. 2

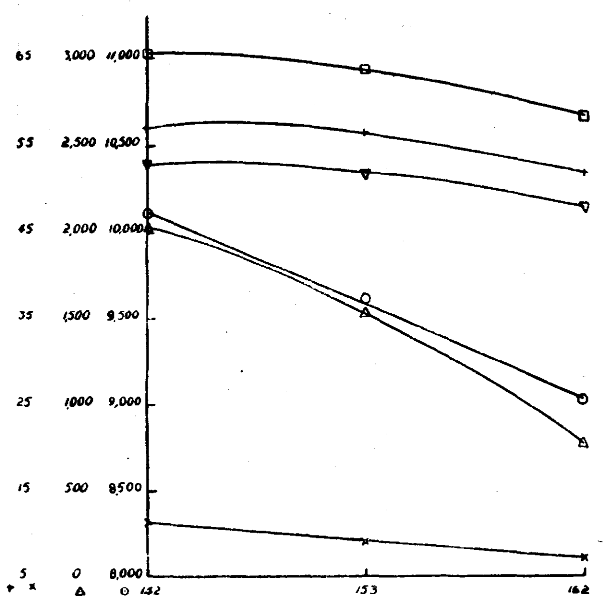


TEMPERATURE (°C.) WITH 22% CHEMICALS FOR 6 HOURS

FIG. 3.

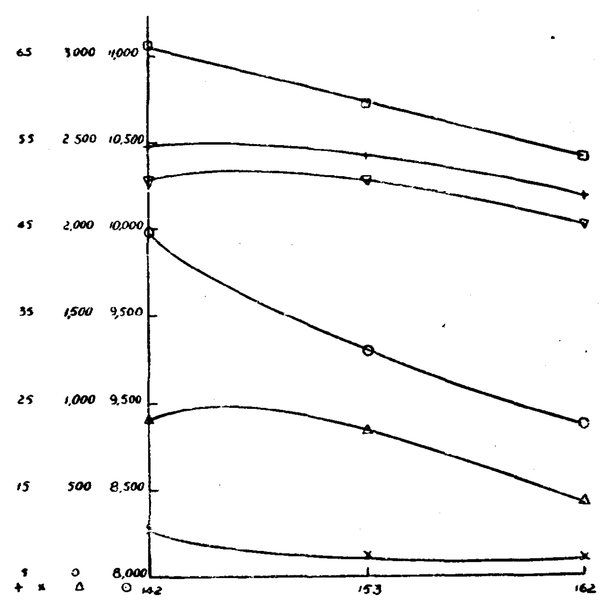
Legend for all the graphs

+ Unbleached pulp yield, %
× Bleach consumption as standard bleaching powder containing 35% available chlorine, %
▽ Bleached pulp yield, %
⊙ Breaking length, metres
⊡ Burst factor
△ Folding endurance, double folds



TEMPERATURE (°C) WITH 24% CHEMICALS FOR 6 HOURS

FIG. 4



TEMPERATURE (°C.) WITH 26% CHEMICALS FOR 6 HOURS

FIG. 5

Legend for all the graphs

+ Unbleached pulp yield, %

× Bleach consumption as standard bleaching powder containing 35% available chlorine, %

▽ Bleached pulp yield, %

⊙ Breaking length, metres

⊡ Burst factor

△ Folding endurance, double folds

TABLE III

Fibre diameter distribution

Diameter of fibres mm.	Number of fibres	% of fibres
Less than 0·01 ..	1	0·5
From 0·01 to 0·02 ..	13	6·5
From 0·02 to 0·03 ..	141	70·5
From 0·03 to 0·04 ..	43	21·5
From 0·04 to 0·05 ..	2	1·0
TOTAL ..	200	100·0

PRODUCTION OF PULP

Several digestions were carried out in the laboratory by the sulphate process using caustic soda and sodium sulphide in the ratio of 2 : 1. The total quantity of chemicals was varied from 22 to 26% on the basis of the oven-dry weight of the chips. The temperature of cooking was varied from 142° to 170°C. One digestion was carried out for 4 hours and all others for 6 hours. This period of cooking includes the time required for the contents of the digester to reach the cooking temperature from 100°C. It took about 30 minutes to raise the temperature to 100°C. from the room temperature.

Air-dry chips (about 200 g.) of about 10% moisture were used for each digestion. The cooking was carried out in a vertical stationary cast iron autoclave of 2·8 litres capacity. The autoclave was heated from outside by means of gas burners. After cooking, the pulp was washed on a 60 mesh sieve and bleached with bleaching powder in two stages. In the first stage, about 75% of the total requirement of the bleaching powder was used. The bleached pulp was beaten in the Lampen Mill till the required freeness was obtained. Standard sheets were made and were tested for strength properties after conditioning at 65% R.H. and 74°F. The brightness of the pulp sheets was determined using Photoelectric Reflection Meter Model 610.

The digestion conditions, pulp yields, bleach consumption, strength properties and brightness of standard pulp sheets are recorded in Table IV and are shown graphically in Figs. 1–5.

PILOT PLANT TRIALS

In order to confirm the results of the laboratory experiments regarding the suitability of this wood for the production of bleached chemical pulps for writing and printing papers, four pilot plant digestions were carried out using each time wood chips equivalent to about 550 lb. (on the oven-dry basis of the raw material). The cooking was carried out in a vertical stationary mild steel digester (100 cubic feet capacity) of indirect heating, forced circulation type. After the digestion, the pulp was washed twice in the digester and finally in a potcher. The pulp was bleached in the potcher with bleaching powder in two stages as in the case of the laboratory experiments. In only one experiment, dry sheets of the bleached pulp were made ; in all the other three experiments, wet laps of the bleached pulp were directly taken to the beater. Beating was carried out till the required freeness was obtained. Requisite

quantities of rosin size, alum, china clay and titanium dioxide were then added. Paper was made on the Fourdrinier machine of the pilot plant. The machine was run at its maximum speed of 50 feet per minute. The running of the papers was satisfactory. No other fibres were used in the furnish.

The digestion conditions, pulp yields and bleach consumption are recorded in Table V and the strength properties of papers in Table VI. A sample each of writing (Table VI, Serial No. 1) and printing papers (Table VI, Serial No. 2) is appended in this bulletin.

DISCUSSION

From the results of the laboratory experiments recorded in Table IV, it is evident that bleached pulps of satisfactory strength properties can be prepared by the sulphate process from the wood of *Albizzia stipulata*. Under the conditions studied, the digestion of the wood with 24% of chemicals at 153°C. for 6 hours gives the best results. This is confirmed by the results of the pilot plant experiments (vide Table V).

It is evident from Fig. 1 that at the digestion temperature of 153°C. there is no appreciable change in the yields of unbleached and bleached pulps when the quantities of chemicals for cooking are increased from 22% to 26%. The bleach requirements decrease with the increase in the quantities of chemicals. The strength properties are maximum when 24% chemicals are used for cooking at 153°C.

Fig. 2 shows that the bleached and unbleached pulp yields are nearly the same at the digestion temperature of 162°C. when the cooking chemicals are increased from 22% to 24% but there is a slight decrease in the pulp yields when the chemicals are further increased to 26%. The bleach requirement decreases with an increase in the quantity of chemicals used for cooking. Contrary to the result obtained with the digestion temperature of 153°C. the strength properties of pulps decrease with increase in the quantities of chemicals used for cooking, the changes being most marked in the case of folding endurance.

Fig. 3 shows the effect of the temperature of digestion on the pulp yields, bleach consumption and strength properties of bleached pulps when 22% of chemicals are used for cooking. There is a decrease in pulp yields with increase in the cooking temperature from 153° to 170°C. but the change is not appreciable, especially in the case of bleached pulps, when the temperature is increased from 162° to 170°C. The strength properties of the bleached pulps have maximum values at 162°C. although an appreciable change is observed only in the case of the folding endurance.

When 24% or 26% of chemicals are used for cooking, the pulp yields and bleach requirements decrease when the cooking temperature is increased from 142° to 162°C. (cf. Figs. 4 and 5). The strength properties of the bleached pulps also decrease with an increase in the cooking temperature.

The results recorded in Tables V and VI indicate that the pilot plant experiments generally confirm the results of the laboratory experiments. The lower values of the strength properties of the paper from the pulp obtained by digesting the wood at 162°C. with 24% chemicals compared to 26% chemicals are due to the fact that the bleached pulp was taken out in the form of dry sheets on the Fourdrinier machine in the former case. The yields of pulp from this wood are more than in the case of bamboo. The writing and printing papers made from this wood are characterized by good formation and satisfactory strength properties. Since the wood is not long-fibred, it may be necessary to mix its pulp with about 30% of long-fibred pulp such as bamboo pulp while making paper on a commercial paper machine.

WRITING PAPER

made from the wood of *Albizzia stipulata* (vide Table VI, Serial No. 1)

PRINTING PAPER

made from the wood of *Albizzia stipulata* (vide Table VI, Serial No. 2)

CONCLUSIONS

1. Bleached pulps of good whiteness in 47·8–49·0% yield can be prepared from the wood of *Albizzia stipulata* by the sulphate process. These pulps are short-fibred, the average fibre length being 1·02 mm.

2. White writing and printing papers of satisfactory formation and strength properties can be made from sulphate pulps of this wood. Since this wood is short-fibred, admixture of its pulp with about 30% of long-fibred pulp such as bamboo pulp may be necessary for the production of paper on a commercial paper machine. In this connection it may be noted that the Fourdrinier machine of the pilot plant of this Institute has a maximum speed of 50 feet per minute whereas writing and printing papers are made in this country at a speed of about 300 feet per minute.

Thanks are given to the Divisional Forest Officer, Saranda Division, Singhbhum (Bihar) and the Range Officer, Samta Range, Jaraikala (Bihar) for the supply of the wood for this investigation.

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TABLE IV.—*Sulphate digestions of the wood from Albizzia*

DIGESTION CONDITIONS AND PULP YIELDS

1	2	3	4	5	6	7	8	9
Serial No.	Total chemicals* (NaOH : Na_2S=2 : 1)	Concentration of chemicals	Digestion temperature	Digestion period	Consumption of chemicals*	Unbleached pulp yield*	Bleach consumption as standard bleaching powder containing 35% available chlorine*	Bleached pulp yield*
	%	g./litre	°C.	hours	%	%	%	%
1	22	44	153	6	20·4	54·6	10·9	50·8
2	22	44	162	6	20·6	51·8	9·7	47·5
3	22	44	170	6	20·6	50·5	10·0	47·0
4	24	48	142	6	21·3	57·0	11·1	52·9
5	24	48	153	6	21·8	56·2	9·0	51·4
6	24	48	162	4	21·4	51·8	10·2	47·8
7	24	48	162	6	21·5	51·4	8·0	47·5
8	26	52	142	6	21·9	54·6	10·2	50·2
9	26	52	153	6	22·1	53·7	7·5	50·5
10	26	52	162	6	22·0	49·0	7·1	45·5

* The % is expressed on the basis of the raw material (oven-dry).

† Expressed on the basis of magnesium oxide = 100. The Photoelectric Reflection Meter Model 610 was used for determining the brightness.

stipulata and strength properties of standard pulp sheets

STRENGTH PROPERTIES OF STANDARD SHEETS CONDITIONED AT 65% R.H. AND 74°F.

10	11	12	13	14	15	16	17	18
Freeness of pulp	Basis weight	Breaking length (Schopper)	Stretch	Tear factor (Marx-Elmen-dorf)	Burst factor	Folding endurance (Schopper)	Bright-ness†	REMARKS
c.c. (C.S.F.)	g./sq. metre	metres	%			double folds		
310	57·1	9270	4·0	82·0	57·3	630	61	Well-cooked pulp was obtained.
289	60·1	9350	4·1	84·1	61·8	980	61	Do.
292	61·0	9030	3·8	78·3	52·8	380	62	Do.
300	61·6	10100	4·6	97·4	65·3	2030	62	A few bleachable shives were present.
295	63·0	9610	4·2	92·9	62·8	1510	61	Well-cooked pulp was obtained.
302	60·4	9230	3·6	72·9	51·7	420	62	Do.
308	59·8	9020	3·9	83·2	58·0	790	64	Do.
311	60·8	9980	4·2	91·0	66·0	900	62	Do.
306	60·0	9300	4·0	89·2	59·6	830	61	Do.
301	59·2	8880	3·6	74·3	53·8	410	61	Do.

TABLE V.—PILOT

Sulphate digestions of Albizzia

1	2	3	4	5	6
Serial No.	Total chemicals*	Concentration of chemicals	Digestion temperature	Digestion period	Consumption of chemicals*
	%	g./litre	°C.	hours	%
1	22	44	162	6	20·8
2	24	48	153	6	21·8
3	24	48	162	6	22·2
4	26	52	162	6	22·4

* The % is expressed on the basis of the raw material (oven-dry).

TABLE VI.—PILOT

Strength properties of papers from pulps described in Table V. Serial Nos. in this Table

1	2	3	4	5	6		7		8	
Serial No.	Freeness after the addition of size, etc.	Ream weight 17½"×22½"—500	Basis weight*	Thickness	Tensile strength (Schopper)		Breaking length*		Stretch	
	c.c. (C.S.F.)	lb.	g./sq. metre	mils (1/1000 inch)	kg. breaking strain for 1 cm. width		metres		%	
					Machine direction	Cross direction	Machine direction	Cross direction	Machine direction	Cross direction
1	80	19·2	63·1	3·20	4·04	2·13	6400	3380	2·1	4·0
2	135	20·0	66·1	3·40	4·88	2·50	7380	3780	2·0	3·5
3	122	18·7	62·3	3·25	3·54	1·94	5680	3110	1·7	2·9
4	145	19·4	63·8	3·10	3·90	1·81	6110	2840	2·2	4·7

* For calculating this, oven-dry weight of the paper was used.

PLANT TRIALS

stipulata and pulp yields

7	8	9	10
Unbleached pulp yield*	Bleach consumption as standard bleaching powder*	Bleached pulp yield*	REMARKS
%	%	%	
50·6	9·2	49·0	Well-cooked pulp was obtained. The bleached pulp was white and bright. This pulp was used for making writing paper.
48·3	7·8	..	Pulp similar to Serial No. 1 was obtained. Printing paper was made from this pulp.
..	9·4	47·8	Pulp similar to Serial No. 1 was obtained. The bleached pulp was taken out in the form of dry sheets before beating. Printing paper was made from this pulp.
..	8·2	..	Remarks same as in Serial No. 2.

PLANT TRIALS

correspond to Serial Nos. in Table V. The papers were conditioned at 65% R.H. and 68°F.

9		10		11	12	13		14
Tearing resistance (Marx-Elmendorf)		Tear factor*		Bursting strength (Ashcroft)	Burst factor*	Folding resistance (Schopper)		REMARKS
g.				lb./sq. inch		double folds		
Machine direction	Cross direction	Machine direction	Cross direction			Machine direction	Cross direction	
40	42	63·4	66·6	26·8	29·9	180	80	Writing paper. A sample of this paper is appended in this bulletin.
52	55	78·7	83·2	32·8	34·9	340	70	Printing paper. A sample of this paper is appended in this bulletin.
36	38	57·8	61·0	20·3	22·9	35	19	Printing paper.
59	61	92·5	95·6	24·8	27·3	110	40	Printing paper.

MEMORANDUM ON SISAL INDUSTRY

(With particular reference to East Africa)

BY R. D. MALIK

Tanganyika Territory, East Africa

Sisal which is generally produced in East Africa is known as *Agave sisalana* – a name which this hard fibre derives from the seaport of the same name from Yucatan from where it was originally shipped to America.

The history of fibres is closely interwoven with that of the human race. Fibre both in war and peace is essentially an article of importance and no doubt the world can ill-afford to do without it. The East African Sisal is known as a hard fibre and ranks as a best seller. It is a Dollar Commodity. It is mostly used in the manufacture of ropes, and binder twine and the world's consumption is steadily growing. A great deal of experimental work is going on to find out new uses and there is likelihood of this industry ranking as "topmost" in not so far distant future. Apart from its uses for ropes and binder twine, bags are also manufactured from this fibre which have secured a good market. This fibre is known since times immemorial. Mexicans knew it and Carter discovered the Aztec and Maya Tribes using the plant for every possible purpose including food, medicines, clothing and cordage. In 1839, when there was an acute shortage of other fibres, it began to be shipped to America. The Java Sisal Industry is one of the most successful industries of the whole world and to-day East Africa is the world's largest producer of hard fibre.

The Sisal Industry in East Africa is built from small beginnings chiefly between the brief spaces in wars, by British, Germans, Indians, Swiss, Greeks, Dutch and other nationalities who settled in this part of the world.

This plant was first introduced into this country, then German East Africa, by Dr. Hindorf in 1893, who brought 62 parent plants from Florida. Since then, endless efforts have brought about a tremendous change and have altered the course of human attempts from doubts and suspicions to one of the most successful industries this part of the world could boast of.

The following table shows the tonnage produced and exported from East African territories :—

TANGANYIKA

Year	Tons	Year	Tons	Year	Tons	Year	Tons
1913	20,834	1925	18,276	1930	49,962	1942	99,009
1921	7,923	1926	25,022	1931	55,939	1943	102,436
1922	10,224	1927	33,012	1932	60,554	1944	111,228
1923	12,845	1928	36,186	1933	69,600	1945	112,218
1924	18,428	1929	45,728	1934	72,510	1946	106,806
..	..	..	..	1935	82,676	1947	105,548
..	..	..	..	..	..	1948	120,622
..	..	..	..	..	..	1949	123,296

KENYA AND UGANDA

(The latter commenced production in 1935)

Year	Tons	Year	Tons	Year	Tons	Year	Tons
1919	5,872	1925	13,623	1931	15,994	1942	29,751
1920	4,570	1926	14,928	1932	15,385	1943	29,270
1921	5,702	1927	15,839	1933	19,140	1944	31,176
1922	7,172	1928	16,516	1934	24,016	1945	31,682
1923	8,543	1929	15,674	1935	32,710	1946	27,038
1924	10,930	1930	15,947	..	..	1947	28,287
..	..	..	..	..	..	1948	36,021
..	..	..	..	..	..	1949	36,985

The Sisal Plant which resembles the "Pine apple plant", when very young, grows well in East Africa. As the climate in East Africa suits well, the plant has rather havier and pulpier leavers, and after planting at reasonable distances under favourable conditions, reaches maturity from 2½ to 3 years. It has a ten-year cycle. But the growth varies according to climatic and soil conditions. The best soil that suits this plant, is rich forest humus, coral soil on the coast, and volcanic ash. It is grown from sea-level up to as much as 6,000 feet. In Yucatan, its native country the rainfall averages 8 to 10 inches whereas in this country the average is some 35 inches. Although the plant is very adaptable, it however, does not flourish under above conditions equally well and margin has to be left for some obvious reasons.

The leaves grow out from the central spike of the Sisal plant in an attractive manner at an angle of 137½° to each other. As the leaves are forced out and down the bole of Sisal plant by subsequent growth the arrangement retains a perfectly orderly manner. It is, therefore, impossible to use any mechanical device for cutting the leaves, which are cut by sharp knives with hand. This must remain purely a "manpower" feature, in the industry. However, the cutting cycle requires very careful consideration to obtain sustained yields. Bigger estates can, however, afford to cut more leaves and leave less at any time to suit market conditions because by the time the remaining areas are cut, sufficient time will have elapsed for new and sufficient leaves to grow.

The fibre is obtained from the leaf, a succulent plant containing 3 to 5 per cent of extractable fibre. The process of extraction, as is the history of the fibre itself, dates back to stone age when the leaf was beaten by stones to get fibre out. Since then, new methods have been devised for the extraction of fibre; the greatest problem confronting producers being to obtain the largest percentage of fibre. The first machine for this process is called "Raspedor" which is still in use in small estates. This machine is fed by hand and the process of crushing the leaves is very slow. The present machine called "CORONA" (Decorticator) has a remarkable speed and the process of crushing the leaves is automatic. The type invented by the German firm of Krupps is very common, whilst the Robey decorticator – another altered design – now mostly out of use is also suitable for the purpose. This plant can be driven by electric, steam, water and other power. This mechanical process has increased the production, the quality of fibre and also the percentage of extractable fibre to amazing heights. Estates which are equipped with the most modern type of machinery are capable of producing thousands of tons annually. The whole process of the extraction of fibre and

the finishing of the raw product has been well organized providing for checks at every stage. Fibre tests can prove loss in production, causes of which may be attributed to faulty mechanical process, poor soil, bad cultivation, etc., etc.

The modern process of extraction of fibre which is indeed a very simple routine, involves the following operations after cultivation when the leaves reach maturity :—

1. *Cutting,*
2. *Transportation of the Cut Leaves to the Factories,*
3. *Decortication, and*
4. *Drying, Brushing, Grading and Baling.*

1. *Cutting*—Once the Sisal areas are ready to come into production, cutting presents itself as the most important of all operations. It is true that cutting tasks have to be maintained as paying propositions. The African labourer is rather reluctant to go in for this work. Tasks have, therefore, to be fixed in order to get maximum of day's work. Railroads have to be built, well laid out bridges and culverts have to be constructed in order to shorten the distance of rail tracts from the fields to factories. And apart from this, care is also exercised in laying out of "blocks", during the cultivation in order to reduce the distance from rails. Cutters have to get their cut Sisal tied up in bundles for stacking as near to the rails as possible to simplify its loading from Sisal trucks or motor lorries on main roads where tracks are not laid down. As already stated no mechanical device has been introduced for cutting operations, this, therefore, rests entirely on labourers and generally except under abnormal circumstances, the tasks are fairly well carried out. But in some cases inducements in the shape of increased wages or rewards, i.e., bonuses or reduction in tasks of cutters are found necessary and this is done according to the requirements of individual estates.

2. *Transportation*—The question of transporting Sisal from fields to the factories has always been a most important and in some cases critical problem for an average producer. But the tremendous revolution that has been brought about in the whole of the industry from mechanical point of view, has not only eased this problem but has brought it to a very high standard of efficiency and economy. From hand-driven carts, oxen carts, small ½ to 1 ton carrying capacity trucks, and various other means there are to-day in service, light railways on well established concerns with heavy type of Sisal trollies, of 3 to 5 tons carrying capacity, hauled by 30/35 h.p. locomotives. The "locomotive" transportation now is faster, safer and more economical than ever. (But motor vehicles are a common feature of transportation on many estates not so well equipped with light railways). For this, trained staff are employed and the system runs very efficiently under expert supervision. With sufficient rolling stock, anything from 8 to 10 tons of decorticated fibre is an average daily output in factories run on most modern lines.

3. *Decortication, crushing of Sisal leaves*—The process of extracting fibre is called decortication. This has been simplified and is done at a remarkable speed. This is an outstanding achievement of modern mechanical engineering. It is a simple process, and involves no major problem apart from technical defects in the plant : whilst the work is quick, costs are reasonably low. All that is done is to push the leaves from a table on to the conveyor belts which get the leaves rolled on through the grips of rope pulleys right into the "drums" where the leaves are chopped off from either side with sufficient water poured on both the "drums" to wash succulent matter off and clean the fibre. With this, short, rapid and amazing process, clean but a slightly greenish fibre comes out to be picked and dried.

But it is true that expert technical knowledge is essential to maintain the plant in its correct running condition, with proper adjustments of beater knives allowing the required space between them and the concave plates, between which leaves are chopped off. It is true that expert knowledge results in little or no loss of fibre, and clean and less greenish fibre.

With defective decortication, not only considerable fibre is lost but the best quality of Sisal is wasted as it would then be poorly graded in consequence. Attention has also been paid to the question of washing fibre during the process of decorticating, with as much water as possible. This makes the fibre turn out whiter. However, salt water is most undesirable, because experience has taught that the presence of any salt in the finished products of this fibre, results in insect attack.

The next problem is, therefore, to see whether any use could be found for the Sisal waste which could compensate for the low yield of good fibre. But this unfortunately remains unsolved. The Sisal leaf contains from 3 to 5 per cent of extractable fibre and even this depends upon the climate and other causes and also to the relative quantity of water in the leaf. The succulent matter "bagasse", therefore, goes to waste. It cannot even be returned to the land.

Nevertheless, this waste is known to the scientists to contain alcohol. With a view to placing on the market a system whereby alcohol could be extracted on commercial basis thus creating a new market for cheap motor spirit, experiments were carried out in the recent years. Nothing, however, seems to have come out of such experiments. It was also thought possible to produce hard wax from Sisal waste.

4. *Drying, Brushing, Grading and Baling*—After the decortication, comes the last stages of the process of Production. Fibre is commonly dried in sun by spreading it on the "Drying lines" constructed for the purpose. However, different opinions have now come to be formed by producers as well as spinners and experts. The most common source of worry is to dry the fibre in such a manner as to destroy its slightly green colour. Too much drying discolours the fibre. It becomes sunburnt and loses its value of "cream or whitish" colour. Examinations have proved that fibre decorticated under best condition also retains slightly greenish colour (Green Chlorophyll). Careful thought is given to the using of Mechanical dryer. Drying of fibre under the shade of trees is also being gone into. By this process, when the ultra violet light is kept off the fibre it is believed that the fibre will not discolour.

The next process is to brush the dried fibre. This process is not only to remove the loose dust and short fibre but to straighten and polish the fibre as well. It incidentally improves the colouring also. Great pains are taken in this process in order to get higher grades for the fibre, which obtain higher prices in the market. Best quality fibre with bad brushing may be downgraded and thus fail to attract high prices. While grading the following important points, viz. :—length, strength, colour and perfect decortication are observed.

The following are the East African Sisal grading definitions :—

No. 1. Length from 3 feet with average 3 feet 6 inches free of defective decortication.

Properly brushed.

Free of Tow, bunchy ends, knots and harshness colour : Creamy white to cream.

A. Same as Grade I but colour yellowish, sunburnt, slightly spotted or slightly discoloured.

2. Length from 2 feet 6 inches upwards.
Otherwise same as Grade I.

3. Length from 2 feet upwards, consisting of brushed fibre that does not confirm to Grade I, A or 2. Although minor defects in colour and cleaning are allowable it must be free of barky or undecorticated fibre and knots.

3L. Length from 3 feet upwards.
Otherwise the same as Grade 3.

R. Fibre that does not conform to the above mentioned grades as regards length, colour and cleaning but minimum length 2 feet.

Tow 1. Proper tow from the brushing machines. Free of line fibre, cuttings, dust, dirt, sweepings and knots. Colour : Creamy white to cream.

Tow 2. Darker colour allowed. Small percentage of line fibre, long white cuttings and not entirely free of dust, but entirely free of sweepings and knots.

The fibre thus produced and studied in detail in relation to its major utilizations in contemporary industries, possesses the following main intrinsic attributes :

(1) cheapness ;

(2) the fact that is a ready made fibre ;

(3) high tension ;

(4) perfect alignment if isolated as it occurs naturally ;

(5) consistency of length distribution within a leaf, and

(6) whiteness.

Note.—These attributes are not at the moment fully exploited and many immediate potential and assured markets are closed to the raw material, because desirable properties are vitiated by the present methods of manufacture.

The potentiality of entry into certain new uses is well illustrated by the fact that Java Sisal is almost exclusively used for manufactured articles such as dyed matting and superior twines.

The following table shows East African production in tons for the years 1946, 1947, 1948 and 1949 in grades :—

Grade	1946		1947		1948		1949	
	Production	Per cent	Production	Per cent	Production	Per cent	Production	Per cent
				TANGANYIKA				
1.	32,478	30·41	30,170	28·58	32,815	27·20	39,033	31·66
A.	16,976	15·89	15,463	14·65	16,846	13·97	14,601	11·84
2.	13,215	12·37	12,646	11·98	14,451	11·98	16,177	13·12
3L.	23,735	22·22	23,788	22·54	27,749	23·00	24,730	20·06
3.	8,437	7·90	10,456	9·91	12,867	10·67	11,660	9·46
R.	4,101	3·84	4,595	4·35	5,509	4·57	5,579	4·52
Tow 1	5,861	5·49	5,747	5·45	6,432	5·33	7,502	6·08
Tow 2	1,309	1·23	1,613	1·53	2,045	1·70	1,721	1·40
Others	694	·65	1,070	1·01	1,908	1·58	2,293	1·86
TOTAL	106,806	100·00	105,548	100·00	120,622	100·00	123,296	100·00

(*contd.*)

Grade	1946		1947		1948		1949	
	Production	Per cent	Production	Per cent	Production	Per cent	Production	Per cent
			KENYA AND UGANDA					
1.	4,008	14·82	4,558	16·11	4,153	11·53	4,174	11·29
A.	2,989	11·06	2,292	8·10	3,052	8·47	2,808	7·59
2.	5,175	19·14	4,756	16·82	3,993	11·09	3,845	10·40
3L.	2,705	10·00	2,318	8·19	4,058	*11·27*	*6,022*	*16·28*
3.	7,090	26·22	8,109	28·67	10,186	28·28	9,795	26·48
R.	2,474	9·15	3,024	10·69	*5,490*	*15·24*	*5,278*	*14·27*
Tow 1	1,204	4·45	1,458	5·15	2,050	5·69	2,030	5·49
Tow 2	399	1·48	446	1·58	607	1·68	674	1·82
Others	994	3·68	1,326	4·69	2,432	6·75	2,359	6·38
TOTAL	27,038	100·00	28,287	100·00	36,021	100·00	36,985	100·00
			EAST AFRICA					
1.	36,846	27·26	34,728	25·95	36,968	23·60	43,207	26·96
A.	19,965	14·92	17,755	13·27	19,898	12·70	17,409	10·86
2.	18,390	13·74	17,402	13·00	18,444	11·78	20,022	12·49
3L.	*26,440*	*19·75*	*26,106*	*19·51*	*31,807*	*20·31*	*30,752*	*19·19*
3.	15,527	11·60	18,565	13·87	23,053	14·72	21,455	13·39
R.	6,575	4·91	7,619	5·69	10,999	7·02	10,857	6·77
Tow 1	7,065	5·28	7,205	5·38	8,482	5·41	9,532	5·95
Tow 2	1,708	1·28	2,059	1·54	2,652	1·69	2,395	1·49
Others	1,688	1·26	2,396	1·79	4,340	2·77	4,652	2·90
TOTAL	133,844	100·00	133,835	100·00	156,643	100·00	160,281	100·00

	Per cent	Per cent	Per cent	Per cent
Tanganyika ..	79·80	78·86	77·06	76·92
Kenya and Uganda ..	20·20	21·14	22·94	23·08

The baling of the fibre is also an important point. It has to be press packed in order to secure as low a rate of freight as possible, but at the same time not damaging the fibre. By giving too much baling pressure the highest quality fibre is liable to get cut. The most common presses are those of the hydraulic system.

Sisal cultivation—The method of planting Sisal varies considerably according to conditions of soil and climate. In East Africa, the coastal plantations are raised on coral soils which are unfertile for ordinary crops but produce excellent growth of Sisal. The planting in this region has undergone a tremendous change in recent years chiefly due to mechanical

cultivation which has been introduced with the advent of modern scientific methods and also to the great interest taken by capitalists who seem to be more keen on this industry than before.

Hitherto the most common spacing adopted between the rows and plants have been 2 × 1 metres giving 5,000 plants per hectare. But other variations of planting distances have been introduced and prove satisfactory. The Java system of planting "double rows" has also been adopted in many estates chiefly with a view to bringing in mechanical cultivation.

However, the tendency now is to plant wider, in some cases approximately double the present distances. It has been established beyond doubt that where the plants have plenty of room and a free circulation of air, the plants develop much faster and the leaf is healthy and heavier.

It would, therefore, appear to be strictly in keeping with soil and climatic conditions that planting distances are calculated. Estates with limited areas at their disposal are endeavouring to plant as close as possible with a view to having more plants per hectare. But nevertheless, in the up lands of East Africa, where there is a rich volcanic soil, it has been found that plants cannot profitably be planted closer than 8 × 8 feet, i.e., 680 plants per acre. The growth is so luxuriant that there is a tendency for the sharp points of leaves to penetrate the plants in the opposite row which causes damage to the leaves called leaf abrasion.

Sisal grown under very favourable conditions is simply wonderful and as many as 200-250 heavy leaves being produced per plant. Whilst in some cases each leaf weighs anything from 12 to 15 lb., the length is remarkable in as much as it reaches 7 feet or thereabout. The yield exceeds 4 tons per acre in a cycle of 4½ to 5 years and in some cases it is exceptionally high.

The following table shows summary of Sisal areas in *Tanganyika* according to 1949 returns (all figures are in hectares) :

TANGANYIKA		KENYA	
Planted up to 1943	90,911	Details not available.	
Planted in 1943	8,078		
,, ,, 1944	8,823		
,, ,, 1945	13,251		
,, ,, 1946	15,393		
,, ,, 1947	14,431		
,, ,, 1948	19,360		
,, ,, 1949	20,262		
	190,509		
Mature Areas	134,377	Mature Areas	72,500
Immature Areas old areas replanted	26,806	Immature Areas old Areas replanted	11,074
Immature Areas : New development	29,326	Immature Areas : New development	7,640
	190,509		91,214
Mature Areas cut during 1949	109,060	Mature Areas cut during 1949	37,955
Average yield per hectare (tons)	1·1	Average yield per hectare (tons)	·98

Note.—Hectare, in the metric system = 2½ acres (nearly).

The old belief that Sisal could be planted anywhere and in any circumstance is vanishing from the minds of growers. It is considered most essential to have the planted areas cleaned well and properly looked after throughout. This not only facilitates the cutting operation but makes for very good development of plants.

If, after the plants have reached maturity, cutting operations are well planned and carried out without undue delay leaving sufficient leaves poling does not start before reasonable time has elapsed. If the plants are not cut early for the first time, poling sets in almost quickly leaving the plants sterile. This point has to be carefully considered in connection with the installation of machinery.

However, after reasonable time has elapsed, poles do grow and whilst they bear bulbils on them the plants themselves have no more strength to produce fresh leaves. Suckers which grow from the roots are often left in replacement of mother plants in such cases.

Different opinions, however, are expressed in regard to the planting of suckers instead of bulbils and it is commonly said that as far as possible suckers in mature areas should not be left to develop to maturity. In well developed and modern estates with vast areas, suckers are "cut out" during cutting operations and removed from roots during cleaning operations. Thus, original plants are left to last their lives and enable growers to have fine quality of fibre, of almost equal length.

But in other cases suckers are left to develop to maturity in many estates which later come into production. Suckers are also planted in the fields instead of bulbils as they reach maturity a year earlier.

But the general method of planting Sisal is undergoing many changes and the old system of using suckers except under special circumstances is being discarded and instead healthy bulbils are grown in nurseries from where they are replanted in the fields when the seedlings are about 12–13 months old. In this manner optimum sizes of plants are obtained.

Sisal areas are required to be properly surveyed in order to facilitate future plannings. Not only this, well laid out roads, bridges, culverts and rail tracks are needed to speed up transportation of leaves to the factories. Some estates have every reason to be proud of such improvements which have been achieved after years of human endeavours at enormous costs.

A fully equipped, Sisal Estate – (economic unit) is an organization by itself. It requires a competent team of workers. The work on an estate is generally divided into 4 main groups :

(1) Management. (Planning and organization and accounting).

(2) Field (Cultivation and maintenance of new, old and immature and mature areas).

(3) Cutting and transporting of leaves to the factories.

(4) Factory (Process of decortication, drying, brushing, and baling and maintenance of machinery and plant and rolling stock).

A highly experienced technical staff is most essential for the maintenance of machinery and plant on Estates for which there are great openings with promising futures. Expert field assistants are placed in charge of cutting and transporting under the direct supervision of Managers.

The machinery requirements of estates, are indeed very important, installation of which, has now come to be regarded more essential in relation to planted areas, leaf potential

and "required tonnage" in view of the heavy capital invested. Estates with vast planted areas cannot produce the maximum tonnage for lack of adequate machinery and likewise, estates with most up-to-date machinery and plant cannot do their best for want of leaf. It is, therefore, most imperative that planning receives its due consideration in relation to capital which is available, for an undertaking from which fair returns are expected in reasonable time. Any such undertaking, therefore, needs the following, viz. :—

(1) efficient management;

(2) expert technical guidance in matters pertaining to general, development of estates, installation of machineries in relation to planted areas and maximum leaf potential available and the working of such undertakings on the most economical lines.

The following are some of the essential equipments for Sisal estates, requirements of which are based on the above mentioned factors :

(*a*) decorticators;

(*b*) brushing machines, and presses with necessary prime-movers and lighting plants and fully equipped workshops, spares, etc., etc.;

(*c*) locomotives and trollies;

(*d*) light railways tracks;

(*e*) motor vehicles, such as lorries and cars;

(*f*) motor cycles and cycles for staff;

(*g*) necessary buildings, and stores; and

(*h*) agricultural implements.

In short a fully equipped Sisal estate run on economical lines must have a well established and organized system of production which inevitably demands capital. In fact a modern Sisal estate is expected to provide well laid out houses for labourers, staff quarters, factories completely equipped workshops, stores, offices, etc., etc., and amenities including sanitary, health, and recreational services, water-supplies, market houses, cook houses, dressing stations, native allotment and in some cases hospital with experienced staff of doctors and nurses and in some cases mosques, churches and schools are provided. These amenities are free, though Government taxes are collected from the labourers.

The Sisal Industry is one of the largest employers of labour. Often it is found necessary to employ recruited labour force from far off places in order to cope up with developments, production and general plantation work, for vast areas have to be cleared of heavy forest growth, infested with wild game, and Tsetsefly and miles of roads constructed to connect estates with rail heads or shipping ports. The present labour shortage has adversely effected the production programmes of the industry and efforts are being made to obtain Government support in introducing legislation dealing with long term contract for recruited labour force, penalties for desertion and absenteeisms.

The latest Government regulations for the welfare of labourers demand improved housing conditions and better medical facilities on Estates. This is demanding of Industry a heavy capital investment but has no doubt served a useful purpose in increasing in value of properties and has brought about a tremendous improvement in the development of the territory.

The Sisal Industry has played the most remarkable part in raising the standard of living of its employees of all nationalities chief among them being the labourers. The average income of a Sisal labourer is adequate to meet his needs and which no doubt is being revised from time to time to keep pace with the rasing cost of living.

The life and property of an average Sisal labourer is to-day more secure than ever before. Government officials holding the ranks of Labour Officers under the independent department of Labour Commissioners look to the interests of employees under the Master and Native Servants Ordnance of the territories. This Department has its own Medical Specialists also who advise the employers on matters pertaining to the general welfare of labourers, hygiene, and other matters such as the construction of labour lines, sources of water-supplies, feeding (cooked and uncooked meals), etc. Periodical inspection by Government Officers is a common feature these days.

Apart from housing accommodation provided free to labourers two types of wage scales are applicable in the industry, viz.:

(*a*) Cash wages based on a 30-day working contract plus Production Bonus if the contract called "Labour Card" is finished within 42 days from the date of commencement this entitles the worker to get weekly "Advances in cash".

(*b*) Cash wages based on a 30-day-working contract plus free ration (cooked and/ or uncooked – the latter being a common feature). There are two types of Production Bonuses which are applicable under this category, e.g., a lump sum Bonus paid on completion of a specific term of contract entered into between the employer and employee in accordance with the international labour laws or a fixed sum payable on completion of every labour card if it is completed within 42 days from the date of commencement. This also entitles the worker to weekly advance in cash.

Note.—The Labour wages on "per day" basis are in relation to "tasks" performed by labourers.

Recruited labour force is entitled to free repatriation on the completion of contract and is provided with various amenities such as free issue of blankets, gunny bags, cooking utensils, water carrying drums, and tins, etc., etc.

Vast sums have been spent by the recruiting organization of the industry in opening up new recruiting centres. Reconditioning camps have been erected *en route* to stop the spread of infectious disease from one district to another.

Once recruited labourers have been delivered to the estate in accordance with allocations which are based on "produced tonnages" it is then the responsibility of estates concerned to look after the health of such labourers. Often, when due to sudden changes in climatic conditions, which are not obtaining in the home districts of recruited labourers, their health deteriorates, and especially when medical authorities recommend the labourers as unfit to work, they are repatriated to their home districts.

The labour tasks are generally established on conditions obtaining on estates in every district and in some cases there is a uniformity of the tasks throughout the industry as a whole. But variations are bound to creep in some cases chiefly due to labour shortage and the trend of labour mentality which has undergone many changes of late. With the opening up of many other great undertakings and the inducements offered to labourers to divert their attentions from Sisal Industry great problems confront this Industry as a whole and desperate attempts are being made to keep pace with essential requirements of the Industry.

The average income of Sisal labourers as it has already been said is quite adequate and the general improvement in conditions affecting him have influenced his social and economic outlook to a very great extent. However, one major obstacle in the way of increased production apart from scarcity of essential materials, and machinery and spares, which are in short supply throughout the world and which hinder all attempts to increased productions

is to increase the average African's incentive to work. The fact that African's needs are limited, and with his mind preoccupied with his old tradition of sticking up to his own small piece of land where he grows his own food, is the chief reason for his lack of initiative to work regularly. This is why absenteeism is reaching high peaks in this part of the world. This, it is believed, will not show any marked change for sometime to come. It is suggested that if more and more consumer goods are available to which a worker may be attracted to spend his savings, it would perhaps bring about a change in his mentality and increase his incentive to work more.

It is generally assumed that if labour position was not so serious, and incentive to work was on the increase, tremendous economic prosperity would have been brought home due to increased production. Not only this, Government revenues would also have increased enormously.

The following table shows the export figures of Sisal fibre of East Africa for the years, 1946, 1947, 1948 and 1949 :

Quantity (tons)				Value (£)			
			TANGANYIKA				
1946	1947	1948	1949	1946	1947	1948	1949
111,521	95,856	117,801	132,514	3,916,405	5,469,443	8,930,461	11,111,232
			KENYA AND UGANDA				
28,826	24,960	30,632	34,291	940,057	1,395,374	2,409,859	2,919,947
			EAST AFRICA				
140,347	120,816	148,433	166,805	4,856,462	6,864,817	11,340,320	14,031,179

The capital needs of the Industry are immense. The good old days when the Industry was in its infancy, are stories of the past, and these are not economic propositions these days. Time has come when this Industry is required to be established on nation wide basis. For as it is already mentioned before, this hemp is essentially a raw material in short supply. Its uses in war are more necessary than in peace time. One may pull carts with hands, or tie bundles in harvest with substitutes, but surely Navy needs ropes, and the demands are great.

Before the war, the world annual consumption amounted to just over 50,000 tons of which two-thirds was Sisal and one-third Manila. But ever since, demand is on the increase and production finds difficulty in keeping pace. Before the war, Sisal prices were so meagre that they did not allow of reasonable returns on capital investments. Many world markets were closed to it chiefly due to different conditions under which world markets were functioning under the policies of their Governments. East African Sisal never found its way in full quantities in many world markets. North America used to import little quantity in keeping with her requirement in the spinning industry. But it was found necessary to export Sisal to America due to the advent of Japan in the late War when, Java, Sumatra and the Philippines were overrun by the enemy and supply lines cut off.

Thus by 1939, East Africa ranked as the greatest producer of hard fibres in the sterling area with an annual output of 120,000 tons.

The Netherlands produced 80,000 to 90,000 tons. Mexico had about 70,000 tons to export, after a balance of about 30 to 40 thousands tons for local manufactures.

Approximately another 40,000 to 60,000 tons were produced by Cuba, Haiti and the Portuguese and French dependencies in Africa. The Philippines, the only producer of Manila, produced a tonnage nearing 170,000 of which one-third was produced during the Japanese occupation.

In 1940, during the bitterest days of European war and the blockade which cut off the European markets, it was found necessary to cut East African Production by 20%, a position which lasted until 1942 when Sisal was given first priority.

The desperate attempts of the American Government to produce Sisal in the rich food growing areas of Wisconsin, and Central America, and the Caribbeans, failed inspite of the fact that huge capital was spent. It was only the East African production that met the requirement of the Allies.

The story of Sisal price is strange. After the 1914–18 Great War, the controlled price of this essential material was £99 per ton and it commenced to fluctuate down to an average of say £40 per ton up to 1930–31, when the great world depression set in and changed the course of events. The result of this deadly depression was so terrible that prices dropped to almost half. There was great disappointment and the future of the industry just hung in balance. There were no better paid jobs and profits were undreamed of. Then the question was how to get through and the fate of "small growers" was indeed miserable.

Prices kept fluctuating as much as 75%, without any ascertainable relation to supply and demand inspite of the fact that consumption was growing steadily.

During the last war, Sisal demand grew enormously and the price of East African Sisal was controlled by the British Government on a basis of £20 per ton below the price paid by America to other growing centres.

Under the lease lend agreements the British Government undertook to supply American Government with a substantial quantity of East African Produce. Price differences also existed for supplies to Russia, India, Australia and South Africa.

During the early stages of War, some hope was, however, entertained that Sisal prices will rise. But this Industry did not feel like pressing the government for any substantial increase until recently when the cost to produce one ton of Sisal was almost four times or more of what it used to be in the pre-war days. This was chiefly the result of the rising prices of all the goods which are used in the Industry such as the Agricultural implements, rolling stock, increased prices of spares, oils, food stuffs and bonuses to staff as compensation for the rising cost of living was also one of the chief reasons.

In 1945, the average Sisal price was £27–15s., and on strong representations made by the Industry's association, this price was increased by £18–9s., per ton till the end of 1947, which works out to an average of £46 per ton on all grades.

The C.I.F. price was about £60 per ton or just over 6d per lb. which was regarded as reasonable.

Another average increase of £10 per ton was announced by the Board of Trade to take effect from 1st January 1948, and the Ministry of Supply's contract extended to June, 1948.

Note.—The prices of Sisal produced by other countries were then as follows :—

Mexican £57 per ton.

P.E. African £55 per ton.

In free markets the price was almost above £100 per ton. The Chilean hemp was £175 a ton and Turkish £300 per ton. (These are soft hemps which are used for special cordage purposes).

At the time of writing, the average c.i.f. price per ton works out to £240 for all grades.

The present prices no doubt will enable the growers to retain good margin of profit and will also enable them to invest more on future demands for replacement of worn-out machineries, rolling stock, etc., etc. Also new development will not lag behind. Vast areas throughout the Territory need replanting and any reserves in capital will serve the purpose of obtaining Mechanized units and various other agricultural implements in short supply, at higher prices.

Once the Industry has its own capital, future developments will show a marked change in the economic advancement of the country. With better wages to thousands of African labourers the nations standard of living is liable to get a strong impetus. Apart from this, government revenues are also increasing from all directions principal among them being the "Import and export" for replacement of worn-out materials, for heavy machinery rolling stock and additional installations mean heavy importation.

The future of Sisal has become a common topic of the day and great speculations are discussed around the corners and in the open.

The general belief that the world's consumption of hard fibres is not going to last for any longer period than what is most necessary "period or replenishing stock" and the many arguments which are brought forth in support of this contention are receiving wide spread propaganda. The fact that this hemp is mostly used for binder twine, which will be replaced by other substitutes and mechanical means of collecting harvest though reasonable may have to be refuted. Whatever may be the substitute and in which ever manner it is introduced it will surely take time which may safely be put at some years. It must inevitably take years for the devastated industries of Europe to come into being again and whatever is produced or may be produced for sometime has a ready market which goes to those on the "waiting lists" of great many nations. Thus, it may be argued that the essential commodity that Sisal is, has its own future well secured for years to come.

Not only this the big bosses in this industry who work whole heartedly for the general well being of the industry as a whole in purely voluntary capacities through the growers own associations and the East African Sisal Boards under government aegis are not leaving any stone unturned in the way of organizing a marketing system whereby prices to growers will be based on reasonable return on capital and working costs. It is suggested that a network of selling organizations be set up with the Industry's own price stabilization board, which will control the future price and the marketing policy of this product.

The world wide shortage of hard fibres cannot be eased quickly and with the present trend of events throughout the world, there seems every possibility of increasing demands being made for this raw product. A substitute may be found for collecting harvest but what of the cordage and rope demands for the ship-building programmes ? In Jute starving countries if some of the Sisal products could as usefully be employed as those of the Jute itself there is every possibility that this general belief will receive some careful consideration.

However, the past history of this industry has proved beyond any shadow of doubt that whatever may be the price fluctuation the world demand of hard fibres have been steadily increasing as is evident from the figures from the producing countries. Nevertheless the question is how to run the industry on economical basis with the interest of the growers not jeopardised and to base the profit of the industry in relation to working costs and in keeping with the percentage of profit of those concerns which utilize this raw product for finished goods. If the Sisal industry could have more understanding from the government there is every possibility that more and more capital will come forward to help, organize and stabilise the industry's long term planning. Every industry needs capital – capital needs a fair return

on investment and if this is assured any industry is liable to survive any world depression. Since this industry is one of the greatest employers of labour a fair share of the profits thus gained will go to change the economic and social outlooks of a vast number of unskilled, semi-skilled, and skilled workers side by side with the advancement in the great industrialization schemes of any country.

The most striking saying that Sisal industry should be established on nationwide basis is surely a matter of great importance and needs a very careful consideration. It is one of the undertakings which could employ thousands of workers by providing them reasonable incomes, and free amenities and cultivate miles of land which is not regarded as suitable for other crops which may be termed as "essential" for any purpose. Apart from this, it is a strategic war material which also helps the increasing industrialization of the country.

The view which has recently been expressed in one of the issues of the Indian Information periodicals that this industry should be established in the Union of India needs careful consideration both by the National Government of India and the industrialists there.

In some parts of India, where the soil and climatic conditions are favourable and easily comparable with those obtaining in East Africa, this industry can be started on large scale *especially in view of the fact that vast areas of land are available.*

The establishment of any such undertaking in present circumstances is not regarded as impossible. With careful planning, and sufficient capital an industry could be established to begin with on a piece of about 5,000 acres somewhere on the coast. This is the only industry which could to-day, employ anything from 3 to 4 thousand workers in the early stages of its existence in any one group or unit.

The East African experience and methods of cultivation could easily be put in hand with confidence. The scarcity of tractors, bull dozers and other mechanical implements for which there is so great a shortage should not be allowed to stand in the way of any such undertaking in India. Even in East Africa, the world's largest producer of hard fibres, the majority of estates have no mechanical methods or means of cultivation. Though there are mechanized units in operation on various estates, this is not regarded as essential, as the world civilization has not yet reached such a stage as to revolutionize any industry and do away with manpower so abruptly.

It appears to be quite reasonable a suggestion to put to the Indian Government and those interested in the uplift of that Sub-Continent, where millions are to be provided with jobs at a reasonably high standard of living. With the present critical position and the situation created by the Refugee Rehabilitation problem this suggestion gathers support in some circles which believe that the labourers from among the refugees, could easily be employed at a reasonable standard of living not at the cost of the government but that of the public directly. Public owned companies could be floated to start this great and new industry where thousands of such refugees could be employed instantenously without bringing any pressure to bear on the Government and its Rehabilitation Schemes.

The following conditions may prove satisfactory and receive the approval of the authorities concerned for the introduction of Sisal industry in India :—

(1) that suitable land is made available at once at a reasonable annual rental ;

(2) *necessary permits be allowed for the purchase of building materials and essen*tial equipment on priority basis, for the construction of labour camps, staff houses and the erection of other necessary stores, godowns, factories, etc. ;

(3) that the government should arrange for the import of seeds from East Africa ; and

(4) employment of refugees be allowed on the following terms and conditions :—

(a) that the labourers are delivered to the growers on say two years' contracts ;

(b) wages to be paid in accordance with wages scales applicable to other industries where similar conditions prevail such as free housing, medical aid, water, fuel and social amenities (other conditions of service to be decided upon) ;

(c) after a specific period of service if refugee workers prefer to go back to their homes they should be repatriated at Government expense, but if they do not prefer to return and wish to stay on facilities be provided for such workers to establish themselves permanently on estates or on "Government land" which may be granted to such refugee workers as a compensation from Government. This type of Refugee Rehabilitation will enable the coming into being of villages from where the future manpower needs of the estates could be obtained ;

(d) government grants to help growers to provide social amenities should be considered ;

(e) wages to workers be paid on 30-day-working basis with or without ration as may be authorized by the existing government rationing scales ;

(f) facilities be provided for labourers to get cash advances weekly ; and

(g) compensation, bonuses and other privileges to be decided upon by the growers and labour authorities.

Any scheme for the starting of this Industry on more of less the basis mentioned above will bring two-fold advantages to the nation :—

(1) the introduction of a new and great industry capable of supporting itself and thousands of its employees ; and

(2) a quick, efficient and reasonable wage earning Refugee Rehabilitation Programme.

How true the cry !

"give us the tools and we shall finish the job".

The potentialities of Sisal are great, with its uses still greater both in war and in peace.

If Sisal produced in India is not meant for export it could easily be consumed in her spinning industry and for the ship building programme.

India has a great future. Her industries are being expanded not only to control foreign markets but for the advancement of the country itself. It may be argued that India's needs of Sisal hemp are limited which could be met from outside but who knows what is store for that great country ? Now as never before has risen that time when side by side with that great Industrial expension both the Industrialists and Government should not lose sight of this great raw product which may become the sheet anchor of the economic stability of South-East Asia.

Sisal is a necessity and India must have it.

WILD-LIFE PRESERVATION IN BOMBAY STATE

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PART II

The Bombay Wild Animals and Wild Birds Protection Act, 1951 has come into force from 1st of May, 1953 under Government Notification No. 5991, dated the 7th April, 1953 and the Bombay State is first in the field in the Republic of India to have given the lead in preservation of 'Wild-Life'.

Organization—With a view to create an effective administrative machinery to implement the provisions of the Act and the Rules made thereunder, services of the three important Departments of the State, viz., Forests, Revenue and Police, have been co-ordinated both by appointment as Game Wardens, Assistant Game Wardens and by delegation of powers for registration of arms and issue of game licences.

Appointments (Section 4) – (*a*) *Game Wardens*—The Divisional Forest Officers, Sub-Divisional Forest Officers in charge of independent Sub-Divisions have been appointed as Game Wardens within their jurisdictions and *Prant* Officers have been appointed as Game Wardens within their jurisdictions constituting non-forest areas and further vested with powers under Sections 44 and 46(1) of the Act for dealing in offences and cognizance by the Court.

(*b*) *Assistant Game Wardens*—The Range Forest Officers and Foresters in charge of independent Sub-Ranges and Rounds have been appointed as Assistant Game Wardens within their jurisdictions and the Sub-Inspectors of Police as such in non-forest areas constituting their jurisdictions.

(*c*) *Non-Official Game Wardens*—In addition to official Game Wardens and Assistant Game Wardens, Non-Official Game Wardens have also been appointed to supplement the official administrative machinery. The Non-Official Game Wardens, who have been issued with Identity Cards have also been delegated with powers under Sections 44 and 46(1) of the Act for dealing in offences and cognizance by the Court.

The new set up thus created under the provisions of this Section, which will be subordinate to the Wild-Life Preservation Officer constitutes 70 Game Wardens (including Non-Officials) and 422 Assistant Game Wardens.

Delegation of Powers (Section 5) – (*a*) *Registration under Section 10*—The District Magistrates and Sub-Divisional Magistrates of the Districts and the Police Commissioner, Bombay have been authorized to register (with Registration fee of Rs. 2/- per arm) name and address of any person who holds a licence granted under the Indian Arms Act, 1878 for the possession of arms for sport or protection or who is exempt from the provisions of that Act and possesses arms.

In accordance with Rule 3(3) of the Act, no application for grant of game licence is being entertained in absence of the applicant having registered under the said section.

(*b*) *Issue of Game Licences* (Section 11)—Following Officers have been authorized to issue game licences :—

(*i*) Small Game Licence (*ii*) Pet animals (possession licence)	Territorial Conservators of Forests, Divisional Forest Officers, Sub-Divisional Forest Officers in charge of independent sub-divisions and *Prant* Officers appointed as Game Wardens and the Commissioner of Police, Bombay within their respective jurisdictions.

(*iii*) Big Game Licence (*iv*) Special Big Game Licence (*v*) Pet and other animals (Trapping) Licence	Territorial Conservators of Forests within their respective jurisdictions.

(*c*) *Production of ivory and horn* (Section 41)—Every person who kills an elephant or a bison shall produce its ivory or horn before the following officers within one month of the killing thereof, together with the game licence under which it was killed :—

Territorial Conservator of Forests, Divisional Forest Officers, Sub-Divisional Forest Officers in charge of independent sub-divisions, Police Commissioner, Bombay and *Prant* Officers appointed as Game Wardens within their respective jurisdictions.

State Wild-Life Advisor Board (Section 6)—The Government have constituted the Board consisting of the following *ex officio* and other members under Government Resolution, Agriculture and Forests Department, No. 8332, dated the 3rd June, 1953 :—

1. Chief Secretary to the Government of Bombay (*Chairman*),
2. Shri N. K. Solanki, M.L.A.,
3. Shri V. S. Dongre, M.L.C.,
4. Shri D. V. Koppikar, Dharwar,
5. Shri D. Y. Pawar, M.P.,
6. Shri Humayun Abdulali, Joint Honorary Secretary of the Bombay Natural History Society,
7. Secretary to the Government of Bombay, Agriculture and Forests Department,
8. Inspector-General of Police,
9. Chief Conservator of Forests,
10. Shri. J. A. Singh, I.F.S., Director of Civil Supplies (Fuel and Fodder).

The Wild-Life Preservation Officer would be the Secretary of the Board.

The tenure of office of the non-official members would be for a period of five years from the date on which the Board is constituted.

Record of Game Hunted (Section 12)—For the maintenance of the record of game hunted, etc., relevant forms have been prescribed and the following officers have been authorized for the purpose :—

Territorial Conservators of Forests, Divisional Forest Officers, Sub-Divisional Forest Officers in charge of independent sub-divisions and *Prant* Officers appointed as Game Wardens, Assistant Game Wardens and the Commissioner of Police, Bombay, within their respective jurisdictions.

Close Time (Section 16)—In accordance with the provisions of the Act, the period specified in column 2 of the following schedule has been declared as 'close' time :—

	Close time
(*i*) All wild birds and wild animals listed in Schedule II of the Bombay Wild Animals and Wild Birds Protection Act, 1951, except the following wild birds : (*a*) Bustard (including Great Indian Bustard) (*b*) Pink-headed duck	1st April to 30th September.

(*ii*) (*a*) Black Panther
(*b*) *Cheetah*
(*c*) Indian Lion
(*d*) Indian Wild Ass
(*e*) Brown-antlered Deer
(*f*) Pigmy Hog
(*g*) Bustard (including Great Indian Bustard)
Why included? (*h*) Pink-headed duck
(*i*) Pea-fowl
— do — ? (*j*) White-winged Wood Duck

} the whole year.

Government Trophies (Section 38)—Any game found dead or killed, without a licence in defence of life or property or by mistake or any trophy in respect of which breach of the provisions of the Act has been committed constitutes a Government Trophy and the property of the State Government. With a view to safe-guard against deterioration or loss of such property, the Game, Police and Forest Officers have been authorized to take possession of such property and further adopt effective measures for the protection of the same.

Defence of life or property (Section 50)—In amplification of the provisions of this Section, it has been declared that any wild animal, or wild bird killed or captured under the provisions of this Section in defence of the standing crop or cattle on the land or in defence of himself or any other person shall constitute Government property and treated as Government Trophy for further disposal of it.

Returns—For the purposes of statistical data and record, following returns have been prescribed :—

(1) Monthly Return in Form No. I regarding Registration of name and address under Section 10 of the Act from the District Magistrates of the Districts and the Police Commissioner, Bombay.

(2) Do. in Form No. II regarding game licences issued under Section 11 of the Act from the Officers authorized to issue licences.

(3) Do. in Form No. III regarding game shot under Section 12 and Rule 3(7) of the Act from the Conservators of Forests, Official Game Wardens and Assistant Game Wardens.

(4) Do. in Form No. I regarding game trapped under Section 12 and Rule 3(9) of the Act from the Conservators of Forests.

(5) Do. in Form No. V regarding persons residing in Game Sanctuaries under Sections 28 and 29(2) of the Act from the Conservators of Forests.

Game Licences issued under the Indian Forest Act—The validity of the game licences issued under Section 26 of the Indian Forest Act is under consideration of the Government, whereas the *free* game licences issued to certain Forest, Police and Revenue Officers by virtue of their official position, and the various Research Institutions, have been invalided under orders of the Government and withdrawn.

Conclusion—With all the will in the world of Wild-Life Preservation Department and the administrative set up created under it and backed by the 'Game Laws' governing the

killing of Wild-Life, the success of Wild-Life conservation, as I have already pointed out and bears repetition, must depend predominantly on the completeness with which Wild-Life problems and their implications are known, or on the extent to which public opinion accepts them, and therefore, gives support to the necessary measures of conservation. It is necessary that we must preserve the balance of nature between the vegetable and the animal kingdoms and amongst the animals themselves. It is only when the balance of nature is disturbed and small game is destroyed and rendered scarce that carnivora turns into a *cattle-lifter* or *man-eater*. Apart from ethics of it we cannot afford to neglect the scientific side of Wild-Life constituting evolutionary, ecological, geographic and biological aspects which remains to be explored and investigated in its natural habitat.

THE CORRECT IDENTITY AND STATUS OF *FLACOURTIA RAMONTCHI* L' HERIT. AND *F. SEPIARIA* ROXB.

BY M. B. RAIZADA, F.N.I.
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In connection with the publication of 'The Wealth of India' Shri K. R. Ramanathan, Assistant Editor, Botany, Publication Division, Council of Scientific and Industrial Research, New Delhi, sent me an interesting enquiry which prompted me to investigate the correct identity and status of *Flacourtia ramontchi* L' Herit. and *F. sepiaria* Roxb. The query, which is self-explanatory, is reproduced below verbatim :

"I am writing this letter soliciting your kind help regarding some doubts about the nomenclature of *Flacourtia* spp.

According to Merrill, *F. indica* (Burm. f.) Merrill includes both *F. ramontchi* L' Herit. and *F. sepiaria* Roxb. Van Slooten (in *Bull. Jard. Bot. Buitenz.* 1925, 7, 368) follows Merrill in including both species under *F. indica*. The later authors, however, appear to entertain some difference of opinion regarding, whether the two species occurring in India are to be considered synonyms of *F. indica* or only one of them. Burkill (D.E.P. Malaya, I) and Benthal cite *F. sepiaria* as the only synonym and the latter author even mentions *F. ramontchi* separately. Bailey in Manual of Cultivated Plants, 1949 and Standardized Plant Names gives *F. ramontchi* as a synonym of *F. indica* and keeps *F. sepiaria* separate. We are anxious to know, therefore, which of these interpretations is correct or whether both *F. ramontchi* and *F. sepiaria* can be included under *F. indica*. I shall be thankful to you for an early reply ". - K. R. Ramanathan, 4th January, 1953.

Let us at the outset examine Merrill, for it is he, as pointed out by Blatter (Journ. Bom. Nat. Hist. Soc. 31 (1927), pp. 912–913), who is entirely responsible for the confusion and I quote the following extract from 'An Interpretation of Rumphius' *Herbarium Amboinense* by E. D. Merrill' (1917), p. 377 :

Flacourtia indica (Burm. f.) comb. nov.

Gmelina indica Burm. f. Fl. Ind. (1768) 132, t. 39, f. 5.

Mespilus sylvestris Burm. Index Univ. Herb. Amb. 7 (1755) [18] (type !), *non* Burm. l.c. [14].

Flacourtia sepiaria Roxb. Pl. Coromandel. 1 (1795) 48 t. 68.

Flacourtia ramontchi L' Herit. Stirp. Nov. (1784–5) 59, t. 30, 31.

Spina spinarum i, *mas* Rumph. Herb. Amb. 7, 36, t. 18, f. 1, 2.

Spina spinarum ii, *femina* Rumph. l.c. 37.

'This species is not represented in our Amboina collections. Rumphius states, however, that the plant was an introduced one there originating in Java, where it was common. *Spina spinarum* Rumph. is the whole basis of *Mespilus sylvestris* Burm., as published on page 18 of his Index Universalis ; it is not included in the Index Kewensis. The name is invalid, however, because Burman published the same binomial on page 14 of the same work for an entirely different species, *Carissa carandas* Linn. (see p. 425). I consider that the form figured and described by Rumphius is the same as *Flacourtia sepiaria* Roxb. from which I cannot distinguish *F. ramontchi* L' Herit. Linnaeus cites the first figure as a synonym of *Carissa spinarum* Linn., but the plant actually described and hence the type of the species is a true *Carissa ;* figure 3 of the same plate, the type of *Mespilus sylvestris* Burm. Index Universalis [14] non [18], is

apparently a true *Carissa*. Linnaeus, in his erroneous reduction of *Spina spinarum* Rumph., was followed by Murray, Lamarck, Willdenow, Roemer and Schultes, Dietrich and Pritzel. Loureiro, Fl. Cochinch. (1790) 634, cites the Rumphian species under *Stigmarota jangomas* Lour. = *Flacourtia jangomas* (Lour.) Steud. By other authors it has been referred to *Damnacanthus indicus* Gaertn. of the *Rubiaceae ;* to *Flacourtia jangomas* Steud. ; to *Roumea* sp. = *Flacourtia ;* and to *Flacourtia cataphracta* Roxb. It is possible that *Spina spinarum* ii, *femina* Rumph. represents a species different from *Spina spinarum* i, *mas*. Burman's *Gmelina indica* supplies the oldest valid specific name for the species and is here adopted. Burman's type was from Java, for which he cites the Javanese name *Doery roekan*'.

Thus far Merrill. As all the material and literature which he used are not at my disposal I can only consider his statements. He says: '*Spina spinarum* Rumph., is the whole basis of *Mespilus sylvestris* Burm., as published on page 18', and later on: 'I consider that the form figured and described by Rumphius is the same as *Flacourtia sepiaria* Roxb.' From this it follows that *Spina spinarum* Rumph., *Mespilus sylvestris* Burm. and *Flacourtia sepiaria* Roxb. are different names for the same plant. But here the all important question arises: What plant has Merrill in mind when he speaks of *Flacourtia sepiaria* Roxb. ? It cannot possibly be the real *Flacourtia sepiaria* Roxb., because he cannot distinguish *Flacourtia ramontchi* from it.

Now botanists may be divided in their opinion regarding a number of so-called species of *Flacourtia*, but, as far as I am aware, nobody has ever questioned or affirmed that *F. sepiaria*, is not a good species. Not even Hooker f. who took a wider view of the species has made an attempt to combine *F. ramontchi* with *F. sepiaria*. Nobody who has seen specimens of the two species in their natural habitats has thought even for a moment that they are identical and belong to the same species, whatever the delimitation of *F. ramontchi* may be.

The same difficulty arises when Merrill says that Burman's *Gmelina indica* supplies the oldest valid specific name for the species. To which species of *Flacourtia*, does the plant belong which he considered to be identical with *Gmelina indica* ? To this we cannot receive a satisfactory answer because for Merrill there is no specific difference between *F. sepiaria* and *F. ramontchi*. It is my impression and belief that Merrill had no good specimen of *F. ramontchi* at hand and that this fact is to blame for the mistake. Until and unless this question is cleared up and settled I prefer to adhere to the names *F. ramontchi* L' Herit. and *F. sepiaria* Roxb.

From what has been stated above it is clear that in the present state of our knowledge we cannot agree with Merrill's reduction. I know the two species of *Flacourtia*, viz., *F. ramontchi* L' Herit. and *F. sepiaria* Roxb. well enough in the field and to me they appear absolutely distinct and easily separable. I give below a simple key to distinguish the two species.

A thorny shrub, leaves 1–2 inches long, obovate, flowers usually on the thorns, pedicels nearly or quite glabrous, stigmas 3–4 .... *F. sepiaria*.

A small thorny tree, leaves 2–4 inches long, ovate, usually glabrous, flowers not on the thorns, stigmas 5–11 .... *F. ramontchi*.

In order to make myself perfectly clear I give below the synonymy, description and distribution of the two species of *Flacourtia** discussed above :

Flacourtia sepiaria Roxb. Cor. Pl. i (1795) 48, t. 68; Fl. Ind. ii, 835; Royle Ill. i, 73; F.B.I. i, 194; Cooke Flora Bombay i, 56; Talbot For. Flora Bombay i, 78; Gamble Flora Madras i, 54; Haines Bot. Bihar and Orissa 36; Blatter in Kirtikar and Basu Ind. Medicinal plants i, 222 – *F. obcordata* Roxb. Fl. Ind. iii, 835 – *Sideroxylon spinosum* Willd. Sp. Pl. i, 1091. Rheede Hort. Malab. v.t. 39.

* Incidentally the correct name of *F. cataphracta* Roxb. is *F. jangomas* (Lour.) Raeusch. Nomencl. Bot. ed. 3, 290 (1797) as it is based on *Stigmarota jangomas* Lour. Fl. Cochinch. 634 (1790).

Description—A very thorny small rigid bush ; thorns straight sharp, up to 5 cm. long, sometimes branched, many of them bearing clusters of leaves and flowers, and longer than the leaves ; twigs pubescent. Leaves on the young shoots alternate, on the older fascicled, small, 2–3·5 cm., by 12 mm. very rarely 2·5–7 cm. in luxuriant plants, elliptic, obovate or obcordate, or orbicular, rarely oblong or oblanceolate, cuneate or narrowed at the base or cordate, more or less crenate-serrate except at the base, glabrous, stiff ; secondary nerves 3–4, reticulate between ; petioles 3–6 mm. long, often pubescent. Flowers dioecious, small, axillary, greenish, solitary at the ends of the short shoots or in racemose clusters shorter than the leaves. Male sepals ovate, obtuse. Female flowers on pedicels up to 5 mm. long, sepals orbicular. Stigmas usually 3–4, on short styles. Berry globular smooth, reddish, turning dark coloured when ripe, about 6–10 mm. in diameter, edible ; pyrenes angular, rugose ; testa smooth.

Distribution—Kumaon, dry jungles throughout Bengal, Bihar, Orissa, Upper Burma, Andamans, the W. Peninsula, scrub forests in all districts of the Madras State, especially on the Coromandel Coast and in the Deccan.

Flacourtia ramontchi L' Herit. Strip. (1784) 59, tt. 30, 30B ; Wt. Ic. t. 85 ; F.B.I. i, 193 (partim) ; Brandis For. Fl. 18 ; Cooke Flora Bombay. i, 55 (partim) ; Talbot For. Flora Bombay 1, 76 (partim) ; Gamble Flora Madras 54 ; Parker For. Flora Punjab 22 ; Haines Bot. Bihar and Orissa 37 (partim) ; Blatter in Kirtikar and Basu Ind. Medicinal Plants i, 220. *F. sapida* Roxb. Cor. Pl. i, t. 69 ; Fl. Ind. iii, 835 ; W. and A. Prodr. 29 ; Wall. Cat. 6675 C ; Collett Fl. Siml. 41, Fig. 13. – *F. ramontchi*, var. *sapida* Hook. f. and Th. in F.B.I. i, 193 ; Cooke Flora Bombay i, 55. – *F. ramontchi forma sapida*, Haines in Haines Bot. Bihar and Orissa 37 – *F. ramontchi* var. *ramontchi* proper, Hook. f. and Th. l.c. 193.

Description—A shrub or small tree, deciduous, armed with axillary thorns, and often with tufts of branched thorns on the stem. Leaves variable, 2–9 cm. by 2–5 cm., ovate, broadly elliptic, obovate or suborbicular, crenate or serrate, apex acute or acuminate or rounded glabrous or pubescent above, more or less pubescent beneath ; petiole 5–8 mm. long. Flowers greenish-yellow, dioecious, in short simple or branched usually tomentose racemes. Sepals 4–5, about 2 mm. long, ovate or orbicular, hispid and ciliate, imbricate. Petals O. Stamens numerous ; anthers small, versatile, opening by slits. Ovary on a glandular disk ; stigmas 5–11 free or connate. Fruit 8–12 mm. in diameter, globose, red or dark brown or dark purple, edible ; endocarp hard with as many cells as seeds. Seeds 8–16.

Distribution—Sub-Himalayan tract and outer Himalaya, ascending to 1,200 m. from the Indus eastwards and in the adjacent plains, Upper Gangetic Plain, common in the Peninsula, Western Ghats, forests of the N. Circars and Deccan up to 900 m. Burma in *indaing* and in dry forests.

THE TRANSECT METHOD IN THE STUDY OF PLANT COMMUNITIES IN INDIA

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SUMMARY

The transect method in the study of plant communities is described. The methods of laying a transect, and charting quadrats are given. The ways of collecting and analysing vegetational and environmental data are described in detail and the methods of their representation and correlation with each other are enumerated with examples from author's own work. It is suggested that forest officers engaged in working plan studies may usefully employ this method for collecting data both on vegetation and its environment. The chief merits of this method are its simplicity and the great amount of information if provides at relatively less cost on the present and future condition of crop, both for exploitation and regeneration purposes. It can be usefully employed by students of vegetation throughout the country. The applicability of the method for the study of any type of vegetation is shown and the method can be used in agriculture and grassland studies as well.

Although, India provides unique opportunities and is in a favourable position to lead the world in forest biological research, there has been little advance in ecological studies in this country during the last 30 years. (Champion, 1937, Hewetson, 1951). This is partly due to greater developments in other branches of forestry and botany and partly due to lack of suitable literature and simple techniques and methods for ecological survey of our vegetation.

Clements' (1905) work on research methods in ecology has long become out of print and Tansley and Chipp's book (1926) in which Troup and Stamp included chapters on Indian and Burmese ecology has become out-of-date and contains methods mostly suited to the study of rain forests. In recent years a number of books have appeared on the subject, of which those by Tansley (1926), McClean and Cook (1946), Oosting (1938) and Gates (1950) describe a number of field methods, chiefly relating to temperate forests and grassland communities. Milne (1948) in Africa, and Morrison, Hoye and Hope-Simpson (1949) in Sudan have, however, developed methods in the survey of tropical vegetation. These methods are similar to those followed by Swedish and Finnish forest departments in their national surveys of forests. Although these methods, which I used during my field studies in U.K. and Europe (Puri, 1950 *b* and 1950 *d*), and also in this country (Puri, 1950 *c*, 1951) are now well-known in other countries, they have not been described in detail in any single work and are not easily available to botanical workers or those interested in the study of vegetation in this country. It is, therefore, considered desirable that a suitable field method be described in detail and brought within the reach of students of Indian vegetation.

In my field studies in different types of Indian vegetation during the last three years, the European methods were used (Puri, 1950 *a*, 1950 *c*) with various modifications to suit local conditions of topography, geology, aspect, slope, density of the forest crop, and its type. This has resulted in the formulation of a method which combines the essentials of all known techniques may prove to be suitable for use in this country.

The chief merit of the method is its simplicity and its application in forestry, agriculture and grassland studies. In forestry it can be applied to management, silviculture, valuation, protection, erosion, soil conservation or simply to vegetational surveys. It provides quantitative data to compile a detailed vegetation map, which is not only useful in determining soil

fertility under the prevailing systems of land use for agriculture or forestry ; but is used for following the progress of regeneration, and successional development of plant communities in a natural forest. It can be used for exploitation purposes in forestry and being simple can be applied by forest range officers with a little training. The method is particularly suitable for the study of weeds and to see changes in the quality of agricultural crops due to microclimatic or micro-edaphic variations. It is equally suited to natural vegetation or plantations. In short, it can be applied to study place to place variations in green covering of the earth and its relationship if any, with the complex of environmental factors. The method is described below in detail :—

TRANSECT METHOD

A transect is a line or a belt passing through an area to be studied across the main topographical, geological and geomorphological features. Essentially, it is forester's strip across the stand which is used in volume estimation (Robertson, 1927 ; Thomson, 1947 ; Watson, 1934 ; Weislander, 1935, etc.) and Finney (1947) calls it a "sampling unit". It may be a line or a belt across a plant community, or a rectangular unit in a stand of varying width – from a few feet to a couple of chains or more. The length of a transect is usually not fixed, but depends upon the nature of the study and composition and type of vegetation and its environment.

It is run in a particular direction which is fixed after a thorough reconnaissance of the area with due regard to fertility gradients. As fertility lines in a forest are usually related with level, which coincides with changes in environmental conditions, in hilly areas the transect is laid across the contours, which mark changes in temperature, rainfall and humidity and in certain cases also in soil conditions.

In some cases in the Himalayas, contour lines do not necessarily coincide with fertility lines, especially where the underlying rock strata instead of lying horizontally dip in one or the other direction. In such cases a transect should be laid parallel to the dip of the strata covering both the dip and scarp slopes (Puri, 1950 *a*, 1950 *b*, 1950 *c*).

In still other cases overlying deposits namely, alluvia, flood plains, moraines, volcanic lava, and mud flows or dykes may be present without any regard to contour lines and transect must necessarily run across these features of landscape, if differences due to these factors are to be properly assessed.

In hilly areas a transect must cover at least one topographic unit, which consists of 3 valleys, 3 tops, 3 north slopes and 3 south slopes. In gently sloping areas or those that are dead level the direction of the transect is usually N. to S. or NE. to SW. and length of the transect may be a mile or two so as to sample sufficient variations in forest crop and changes in the soil.

In crops managed under regular systems of management or in plantations the length of the transect is usually longer than in primeval forest. For successional studies the transect is again longer than when the aim is to study only the progress of regeneration. In the latter case transect may be small and a rectangular plot.

A number of parallel running transects should be studied if detailed composition of vegetation with regard to yield of the crop, etc., is desired. But for mere ecological studies of associations a couple of parallel running transects in typical areas have been considered to be sufficient by ecologists in other countries. In primeval or undisturbed forests results obtained by the study of one typical transect laid at the proper place should be representative of the area. In disturbed forests or those that are developed in regions with large variations

in geology and geomorphology the number of transects should be at least three. In vegetation surveys of Sudan Morrison *et al.* (loc. cit.) have been able to collect representative data by the study of a single transect.

Actual recording of vegetation is done in smaller units called quadrats, which in Finney's (loc. cit.) terminology are "recording units". These are either square or circular ; and are of a convenient size, which depends upon the type of vegetation that one is dealing with. For recording trees, and shrubs circular quadrats of 18·6 feet radius are convenient in thick forests. In open forests with little shrub layer quadrats with a radius of 37·2 feet may be used. In respect to acreage the quadrat with 18·6 feet radius is approximately 1/40th of an acre and the other has an area equal to approximately 1/10th of an acre. In double and many storeyed forests where visibility in a line is small and where the ground layer is profusely developed the radius of quadrats may even have to be halved or further reduced for the recording of vegetation.

The quadrats are studied on a transect at suitable intervals, care being taken that these do not overlap and same trees are not counted in two adjoining quadrats.

For ground flora communities and tree seedling growth small quadrats of 1 metre square or 1 yard square are studied in the larger tree quadrats. Depending upon the investigation in view a number of ground flora quadrats are studied in a tree quadrat. In grassland communities, in the study of weeds and agricultural crops, the size of quadrats in nearly $\frac{3}{4}$ or $\frac{1}{4}$ of that used in recording ground flora species in a forest. In the study of other smaller forms of vegetation ; e.g., mosses, liverworts, lichens, etc., the size of the quadrat may not be more than one foot square.

The method outlined here has been advocated by foresters, for example, Lowdermilk (1927) suggested milliacre areas of 6·6 feet square for counting regeneration. Kadambi's (1943) spot method consists of circular areas or spots of one chain radius for complete studies. The study of a larger number of quadrats of a smaller size is advantageous not only for convenience in recording but it takes into account a far greater amount of variation. This method is more accurate statistically.

There has been a good deal of discussion on the methods of selection of transect and quadrats. For volume estimation surveys Griffith's (1945–46) work in different types of forest in India and Finney's (1947–48) masterly discussion seem to show that random selection of transect and quadrats is best from statistical point of view. But from biological considerations ecologists throughout the world have not strictly followed random sampling technique in the selection of lines for laying transects, and in practice some bias is always left in selecting a transect (see Morrison, *et al.* loc. cit.). There are considerations either of the best composition of the community, and its more natural and primeval conditions, or general topographical and environmental considerations that limit the choice. Sometimes the accessibility of the area and convenience of work are also influential in selecting a line for study. Although, strict randomization is usually not done in ecological work, the results obtained by such studies have been invariably found to be representative. This is chiefly due to the fact that the line is laid perpendicular to the fertility gradient and all variations in forest composition due to the fundamental environmental factors are sampled, adequately along this line. The need of randomization is great in highly disturbed forests, but generally ecological work for establishing the relationship between forest and environment is not encouraged in such situations. For ecological work virgin or little disturbed forest areas are selected. Some sort of randomization is done in the selection of ground flora quadrats in a tree quadrat. But here too one is more often limited in choice, especially when the object is to sample only certain types of ground flora communities and to find out the causes that govern the growth

and distribution of only these and associated types of seedling growth. In agricultural and grassland communities where the areas are small and easy to approach and recording is not difficult strict randomization may be done in selecting quadrats. Here the size of the quadrat and the number of the quadrats will also have to be fixed to get a complete picture of vegetation. Subject to these limitations the technique of selection is not different from that used in volume estimation surveys and is in accordance with international ecological methods.

The most interesting and useful part of the transect study is the thoroughness with which the recording of vegetation and evaluation of environment are done in quadrats.

In a tree quadrat all the trees of different species in various layers or strata are counted separately ; and their breast height, diameter or girth taken. The number of poles and saplings is separately recorded. Felled, lopped, burnt or malformed trees are specially mentioned to indicate the human influences that the forest is subjected to. At the time of observation phenological conditions of the dominant species in the community are also recorded. In addition to the quantitative data, qualitative observations on cover, position of tree crown in relation to light intensity, sociability or gregariousness of the species, their stratification, their vitality, and periodicity (in the case of ground flora) are also made.

In ground flora quadrats the presence or absence of ground flora species, seedling growth, etc., is recorded by such terms as abundant (*a*) common (*c*), rare (*r*) present, (+) and absent (—). In regeneration counts only established seedlings are mentioned, though recruitment is indicated. These quadrats are laid at places where one metre square or about that size of patches of distinct ground flora communities with associated tree seedlings are found. It may be pointed out that single isolated plants of a species are not of any importance in indicating environmental conditions. For they may belong to ephemeral species or may be occasionals with low fidelity and low vitality and may not be truly representative of the locality. The study of distinct and compact ground flora communities in larger patches is, therefore, emphasized for ecological purposes (Pearsall, 1938 ; Puri 1950 *d*).

In addition to the ground flora communities and seedling growth data on tree litter, humus, soil colour, texture, its visible micro-fauna (e.g., worms, termites, insects, etc.), and micro-flora (e.g., fungus growth, matted condition of the litter, etc.), is usually observed. The temperature of the air at breast height and at ground level and of the soil at the surface and subsoil (with earth thermometers) is measured to get some idea of the community climate, especially the humidity.

Samples of humus from top, 0″–6″ of the soil or from the rooted region of the seedling growth and ground flora communities are collected from the centre of the ground flora quadrats for detailed analysis according to the lines laid down by Griffith and Gupta (1947) at selected places to study tree roots, and their distribution in the various horizons of the soil. Samples from different layers of the soil in well developed soils, e.g., podsols, brown earths, chernozems, laterites, etc., or from different depths (in azonal soils) are brought to the laboratory for determination of pH, organic matter, exchangeable calcium, exchangeable bases, and nitrogen. Usually in azonal soils, samples are taken from 0, 6, 12, 24, 36, 48 and 60 inches. In rare cases sample from the depth of 6 feet is taken.

The vegetational data is conveniently recorded in ecology note-books, which can be had from the author on request.

The vegetational data is analysed in field or at the laboratory in the following way :

The number of all the trees, saplings, shrubs, etc., in each quadrat is added up and percentage of each species is determined. This gives data for the density of the different species in a unit area (quadrat) and can be made into different density classes. The percentage

of the total number of quadrats in which a species occurs gives frequency. Frequency occurrences are determined for all species in a transect separately or in all the transects studied and are conveniently grouped in Raunkiaer's (1934) five frequency classes (see Oosting, loc. cit.) as follows :

Frequency class A = 1–20%
B = 21–40%
C = 41–60%
D = 61–80%
E = 81–100%

On the basis of 8,000 frequency percentages Raunkiaer found that his frequency class A included 53% of the species B, 14%, C, 9%, D, 8% and E, 16%. On this he propounded his following "law of frequency"

$$A > B > C \underset{>}{\overset{<}{=}} D < E$$

This law can be represented in the normal frequency diagram as shown by Raunkiaer.

After determining frequency classes A, B, C, D, E the frequency diagram is prepared and compared to Raunkiaer's normal frequency diagram.

In addition to these diameter or girth classes can be determined to give an idea of space and cover occupied by each species in a community. This data of density, frequency classes, etc., can be represented in phytographs for various plant communities. Phytographic representation of quantitative characters of plant communities provides useful index for comparing two or more plant communities in a sere or seeing changes in the same plant community at some interval of time (see Rowe, 1949 ; Oosting, 1948). It also evaluates the effect of the prevailing systems of management or silviculture on the composition of forest communities.

The phytographs, frequency diagrams and qualitative data on periodicity, stratification, vitality, gregariousness, etc., give a detailed description of plant communities.

The relationship of plant communities with soil features is obtained by presenting the data in tabular forms with descending or ascending order or by means of graphs, bar diagrams or histograms. The author has employed these methods in his studies of English vegetation. (Puri, 1950 *d*) and also in some studies conducted in this country (Puri, 1950 *c* ; Puri and Gupta, 1951).

The relationship of plant communities with geological features is studied in the field by noting the type of plants occurring on dip and scarp slopes and the data are represented in profile sections made to scale (see Puri, 1949 ; 1950 *a* ; 1950 *c*). Profile sections are also made showing the relationship of soil features with topography and plant communities.

The use of this method is recommended to forest officers for working plans enumerations and other studies in the forest. The data on the composition of forest communities and their relationship to climate, soil, geology and biotic influences given for the divisions in working plans are usually very inadequate and it may be desirable to collect further data by this method for basing prescriptions of management and silviculture. The transect method in enumeration affords a wealth of useful data not only on the present condition of the crop, but the assessment of its dynamic relationships with the soil, succession of plant communities and the ecological nature of the future crops is also made. So far as I know, no data have been collected in any state forests evaluating the effects of the main silvicultural and management systems on the ecological changes in the crop and some of the states desire this problem to be taken up by the ecologist. It will be obvious to the forest officer that the data on the

problem can be easily collected in the forest by the transect method during working plan studies and if this paper gives an incentive to the use of the transect method in vegetation studies in this country we shall have achieved a great deal.

ACKNOWLEDGEMENTS

I take this opportunity to express my thanks to Mr. C. R. Ranganathan, I.F.S., President, Forest Research Institute for kindly going through this paper and making improvements.

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CHEMICAL STAINING OF DEODAR PENCIL SLATS

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SUMMARY

A cheap and simple method of staining pencil slats of deodar by the use of nitric acid is given.

The Eastern red cedar of America (*Juniperus virginiana*) also called the American pencil cedar, is the most popular wood used in the manufacture of the writing pencils. Owing to over-exploitation, the supplies of this species are falling off. Other timbers used extensively in the pencil industry are the Californian incense cedar (*Libocedrus decurrens*) and the East African cedar (*Juniperus procera*). Both of these are, however, treated to improve their cutting qualities and colour. The treatment generally given consists of impregnating the seasoned slats with an aqueous solution of a suitable dye followed by softening with wax, or it consists of impregnation of slats with an aqueous emulsion of wax or oil to which suitable dye has been added. These treatments involve the application of vacuum as well as pressure, and the plant required is costly.

2. The experiments carried out recently at the Forest Research Institute, Dehra Dun show that deodar (*Cedrus deodara*) is an eminently suitable wood for pencils. Under the tool "this timber yields a beautiful surface rivalling American red cedar in smoothness and lustre". However, its light yellow colour is something which the public is not accustomed to in pencils. The staining of the wood to the desired shade can be effected by a method similar to that used for incense cedar*. As a result of the attempts made to develop a cheaper and simpler process for the staining of deodar, it has been found that the pencils slats of this wood can be dyed a pleasant violet colour by keeping them immersed in dilute nitric acid. Incidentally the treatment also improves the cutting quality of the slats.

3. For the purpose of giving the chemical treatment, the air-dried slats are bundled into small stacks with thin wooden strips as crossers. The bundles are then immersed in the acid solution of desired strength and kept in it for the required period. They are then removed, washed with water to remove the acid, air-dried and used.

4. Table I below gives the detailed information with regard to the temperature and concentration of nitric acid, period of immersion and the colour obtained in the slats. Sulphuric acid can also be used in place of nitric acid, but the colour obtained is not as pleasant and uniform as with nitric acid.

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* The details of the treatment are given in the Indian Forest Bulletin No. 149 (Wood Seasoning), published by the Manager of Publications, Civil Lines, Delhi.

TABLE I

Giving shade of colour obtained in deodar slats by keeping them immersed for various periods at different temperatures in solution of nitric acid of different strengths

Strength of nitric acid	Temperature of the solution	No. of days of immersion	Colour obtained
·5 to 1 per cent ..	0°C.	2 to 8	Light violet, not through and through.
5 per cent ..	„	2 to 6	Pleasant violet, through and through.
10 to 20 per cent ..	„	2 to 6	Dark violet or yellow, through and through.
·5 per cent	25°C.	4 to 10	Pleasant, violet, through and through.
1 „	„	2 to 4	Pleasant violet, through and through.
5 „	„	2	Dark violet, through and through.
10 to 20 per cent ..	„	2	Yellow, through and through.
·5 per cent	35°C.	4	Pleasant violet, through and through.
1 „	„	2 to 4	Violet, through and through.
5 „	„	2 to 3	Dark violet, through and through.
10 to 20 per cent ..	„	2	Yellow, through and through.
·5 per cent	50°C.	4 to 6	Pleasant violet, through and through.
1 „	„	2 to 3	Violet, through and through.
3 to 12 per cent ..	„	2	Dark violet or yellow, through and through.

WILD-LIFE PRESERVATION IN INDIA

Some suggestions regarding the composition of State Wild-Life Boards

BY E. P. GEE, M.A., C.M.Z.S.

1. *Introduction*—(*i*) The urgent need for creating Wild-Life Boards in all States has been widely recognized. In November 1952 The Indian Board for Wild-Life recommended that "each State Government should be requested to set up a State Wild-Life Board consisting of representatives of various organizations and interests to deal with the day-to-day administration of local Wild-Life problems". This recommendation was later accepted by the Government of India, Ministry of Food and Agriculture, and was duly transmitted to all State Governments in February 1953.

(*ii*) Recently the Central Board of Forestry at their Conference held at Dehra Dun in June 1953 endorsed the above, and in particular drew the attention of the State Governments to "the need for taking very early steps to constitute State Wild-Life Boards in those States where they have not yet been formed".

(*iii*) The question now arises "What should be the exact composition of a State Wild-Life Board" ? Or rather "What is the ideal composition of a State Wild-Life Board, so that it can function in the best interests of a State's wild-life and of the people of the State" ?

2. *Function and Size*—(*i*) It is presumed that the function of these Wild-Life Boards will be to advise the State Governments in respect of general policy and practical measures to be taken to preserve wild-life unimpaired for the benefit of future generations in the best interests of the people.

(*ii*) A State Wild-Life Board would consist, it is presumed, of both officials and non-officials. With regard to the proportion of official and non-official members, the latter should always predominate in view of the fact that it is the intention of State Governments to seek the advice and support of knowledgeable and influential members of the public in safeguarding a national asset.

(*iii*) With regard to size, a large Board would be unwieldy, while a very small one would not be sufficiently representative of public opinion. The expenditure of public money on travelling allowances will also be a deterrent to a Board being of a large size. The number of ten to sixteen members is suggested as ideal for Part A States : if the number of ten were adopted, a Board could consist of four officials and six non-officials. Of the non-officials, two could resign each year in rotation and be replaced, thus bringing in fresh blood each year and yet ensuring continuity. For other States possibly a smaller Board would suffice.

(*iv*) The members of the first Wild-Life Board of a State would, it is supposed, be appointed by the State Government ; and at the first meeting the Board's permanent composition, constitution and rules would be drafted and finalized.

3. *Official Members*—(*i*) Of official members the first choice would obviously be a Minister, presumably the Minister in charge of Forests, who would be Chairman of the Board. It would be advantageous to secure the patronage of the State Governor or Rajpramukh, if a person of that eminence could find the time and had interest and experience in the field of wild-life.

(*ii*) A most necessary choice, of course, is the Head of the Forest Department of the State concerned, on whom would naturally fall the work of Secretary and Convenor of the meetings. He will be the key man of the Board, for on him will devolve the task not only of putting forward the official view on all matters, but also of later putting into effect the recommendations passed.

(*iii*) Owing to the continuous extension of cultivations into the forests and waste lands, and the "conflict" (real or imaginary) between man's interests and the interests of wild-life, it is essential that the fullest understanding and co-operation of the agriculturist and cultivator in wild-life preservation be obtained. It seems right, therefore, that a highly placed representative of the State's Food and Agriculture Department should be a member of a State Wild-Life Board.

(*iv*) The State Forest Department would probably find it helpful to have another representative of its own Department on the Board, and, therefore, another Conservator or Deputy Conservator of Forests could be appointed. This would have the additional advantage of ensuring continuity of representation of the interests of the Forest Department in the event of the Head of the Forest Department retiring from service.

(*v*) Other officials who might have representation on the Board are the Chief Secretary to the Government, or his deputy ; as District Magistrates will have to enforce old legislation which may be revived and any new legislation which may be introduced. Also the Police, on whom will fall the onus of enforcing law and order against illegal shooting and other infringements of the Game Laws. Also the Armed Forces, among whose personnel there are so many persons interested in sport. All these officials could, however, be omitted from the actual Board itself, and be co-opted whenever a subject of particular interest to them was being discussed or decided on. This also applies to the State's Publicity Department and Veterinary Service.

4. *Non-official Members*—(*i*) While the choice of official members should prove comparatively simple and straightforward on the lines indicated above, the appointment of non-official members will require careful consideration.

(*ii*) One or two influential and knowledgeable M.L.A.'s who could "put it across" in the Assembly and on the platform, would be a great asset to any State Wild-Life Board. But it is essential that the Board as a whole should steer clear of politics. All shades of public opinion should be represented on the Board. The over-riding consideration should be to include knowledgeable persons who can bring an independent outlook to bear on all problems relating to wild-life, irrespective of their political affiliations.

(*iii*) Most important of the non-officials to be appointed would be one or two persons of proved experience and knowledge of wild-life problems and wild-life conservation. Without such persons a Board will be of little use. Field naturalists are preferable to museum or laboratory specialists ; and if a qualified zoologist is chosen he should be a person of practical field experience rather than textbook knowledge. The claims of wild-life conservationists of repute should never be overlooked in the composition of a State Wild-Life Board ; and the appointment of such persons could well be placed in the hands of the Head of the State or of the Executive Committee of the Indian Board for Wild-Life.

(*iv*) Any important organization or interest connected with the study of natural history should be considered for membership. Most States have some kind of Natural History Society, or at least a nucleus of members of the All-India society known as the Bombay Natural History Society ; and from these a representative should be nominated by the Society's committee of management.

(*v*) Similarly any important Game Association in a State should be invited to nominate its representative, as the interests of bona fide sportsmen must always be safeguarded in any scheme for the preservation of wild-life. It is well known that the presence of sportsmen in a forest is always a deterrent to poachers.

5. *Other Relevant Points*—(*i*) In the event of a State possessing some outstanding Wild-Life Sanctuary or National Park, preference should be given to persons residing in that

Great Indian One-horned Rhinoceros in Kaziranga Sanctuary, Assam.

Photo by E. P. Gee.

Wild bull Buffalo in Assam.

Photo by E. P. Gee.

locality when appointing either official or non-official members. Local knowledge and local influence are of paramount importance in such cases.

(*ii*) In any event members of the Board should as far as possible be drawn from different parts of the State concerned. A predominance of members from some particular part or parts of a State would be unfair.

(*iii*) Another possible asset as a member of a State Wild-Life Board might be some influential leader, or someone of great eminence and authority, whose backing in wild-life preservation would be of the greatest moral value. Similarly the proprietor or editor of a newspaper in general circulation throughout the State would be a valuable member of any State Wild-Life Board.

(*iv*) If it is considered desirable to admit as large a number of non-official persons as possible to a State Wild-Life Board, so as to obtain a wider cross-section of opinion and advice, the Board would become unwieldy. Two methods of overcoming this unwieldiness might be : (*a*) to have an "Inner " or "Executive Committee" in control of a larger Board, and (*b*) to have "Associate" or "Corresponding Members" in different parts of the State, who would have an opportunity of expressing their views on any important questions in writing, without actually being on the Board.

(*v*) It is possible that high-ranking ex-officials retired from service, with inside experience of the legal and administrative difficulties, would be suitable for membership – especially if they were also knowledgeable wild-life conservationists or experienced sportsmen.

(*vi*) Some States may already have an appointment for a Game Warden (as in Travancore-Cochin) or Wild-Life Officer. In such cases this official would naturally be on the Board.

(*vii*) The Government of India have recently appointed "Honorary Regional Secretaries for the Indian Board for Wild-Life" for each region of India. These persons are ready to advise States in the matter of the creation of State Wild-Life Boards, and to do everything possible to help in the preservation of wild-life. They are to " maintain liaison between the Central Board and the State Boards ". It would perhaps be right, therefore, that the Honorary Regional Secretary should be an honorary or *ex-officio* member of the State Boards within his jurisdiction, and should attend meetings if and when possible. In any case the agenda and minutes of every meeting should always be sent to him.

(*viii*) The above-mentioned methods of obtaining the best possible representation from the public for the non-official membership of State Wild-Life Boards should also be a guide to the appointing of Advisory or Managing Boards or Committees, or Trustees, for any National Parks which might be created in a State.

6. *Conclusion*—The members, both official and non-official, of a State Wild-Life Board or National Park Committee have a heavy responsibility to shoulder. For in all cases they will be examining problems and making recommendations for legislation, not to solve the difficulties of the present moment but to ensure that wild-life will be preserved for all time.

The wild-life of a State and the areas in which it is found will be entrusted to their stewardship, to provide for the public enjoyment of them in such a way that they will remain unimpaired for the enjoyment of future generations.

ACKNOWLEDGEMENT

This note was shown before finalization to Shri M. D. Chaturvedi, I.F.S., Inspector-General of Forests, and to Shri Salim A. Ali, Honorary Secretary of the Bombay Natural History Society. The writer is grateful to these two persons for the minor amendments suggested by them for its improvement, which have been fully incorporated.

A NEW BURMESE *DILLENIA*

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Dillenia parkinsonii Raizada et Chatterji sp. nov. – Proxime accedit ad *D. auream* Sm. atque *D. andamicam* Parkinson, a quibus tamen differt foliis minoribus atque forma diversis, pedicellis tenuibus atque floribus minoribus (flores vero in nova specie sunt bini vel terni, in *D. aurea* singuli), staminibus plus minusve aequilongis atque in serie una (in *D. andamica* stamina sunt inaequalia atque bis seriata), carpellis paucioribus (in *D. aurea* carpella sunt 8-12, in *D. andamica* 6–8) atque stylis tenuibus (in *D. andamica* stylus est robustus).

A small deciduous tree, young parts appressed silky tomentose. Leaves alternate, 23-30 cm. long 8-13 cm. wide, oblong-ovate to oblong-lanceolate, margin undulate-serrate, apex bluntly pointed, base gradually narrowed into a winged, sheathing petiole, 2–3 cm. long ; lateral nerves 38-46 pairs, excurrent into fine silky teeth ; hairy on both the surfaces, upper surface strigose hairy with somewhat bulbous based hairs, thinly hairy on the under surface and pubescent, specially on the nerves below. Flowers in fascicles, 2-3 together, arising on old wood from the axils of very young shoots, creamish-white in colour (?) appearing with the leaves or before them ; pedicels about 3-4·5 cm. long, slender, thinly appressed-hairy, with or without bracteoles. Bracts 2-3 up to 2 cm. long, lanceolate – acuminate with ciliate margin, caducous, purplish in colour, appressed-hairy on the outside ; bracteoles solitary or absent, more or less similar to bracts except in size, up to about 1 cm. long, very caducous. Sepals 5, about 1·5–2 cm. long 1 cm. wide, in two series – outer of 3 and inner 2, greyish-purple outside and deep-purple inside, thick, longitudinally striate, appressed-hairy outside, glabrous to thinly hairy inside, margin ciliate. Petals 5 (very rarely 6), about 3–4 cm. long 2–2·5 cm. wide, ovate to obovate or oblong, narrowed at the base into a short claw, imbricate, thinly papery on drying, glabrous. Stamens numerous, erect, all more or less of the same size, 11–14 mm. long ; filaments 7–9 mm. long, slightly flattened. Carpels partially fused ; styles 8, erect, long and linear ; ovary glabrous. Fruit not seen.

Moke – Kadoke Chaung Drainage, Mawlaik Dist., 500 feet, Burma, 15th February 1940, Mg Po San (Type in Herb. Dehra Dun) ; Burma, 1939, Silviculturist Burma ; Myitha, U. Chindwin Dist., 550 feet, Burma, 1st February 1952, Tun Hlaing, Min : 4.

Burmese name – Wetzinbyun. ('Wet' in Burmese means 'pig' and' Zinbyun' is *Dillenia pentagyna*).

The type sheet of this species was examined by Dr. N. L. Bor, Asst., Director, Royal Botanic Gardens Kew, who remarked that it did not match with any named species in Herb. Kew.

Dillenia parkinsonii is closely related to *D. aurea* Sm. and *D. andamanica* Parkinson, but differs from them both in the smaller size and shape of the leaves ; slender pedicels and smaller size of the flowers, 2-3 together (solitary in *D. aurea*) stamens more or less of the same size, in one series (in *D. andamanica* stamens of unequal size and in two series) ; in the number of carpels (8–12 in *D. aurea,* 6–8 in *D. andamanica*) and slender styles (stout in *D. andamanica*).

We have great pleasure in naming this species in honour of late Mr. C. E. Parkinson, formerly Forest Botanist, Forest Research Institute, Dehra Dun, who had made extensive collections in Burma and published a critical note on 'Some Indian and Burmese *Dillenias*', (*Indian Forester* 61, 1935).

Dillenia parkinsonii M. B. Raizada et R. N. Chatterji.

This species has an interesting history behind it. It was detected as a new species as early as in June 1942 and reported as such in the progress report of the Botany Branch, Forest Research Institute. Due to lack of fruiting material and the difficulty in procuring the same from Burma during the war period, the country being then under Japanese occupation, it was not considered desirable to publish the technical description of the plant. Attempts to secure fruiting specimens having since regularly failed, it has now been ultimately decided to publish its description, lest the interesting find should be lost sight of. In the meantime (1951), at the request of Dr. H. J. Lam, Director Rijksherbarium, Nonnensteeg, Leiden, Holland, the entire herbarium material of the family *Dilleniaceae* belonging to the Dehra Dun Herbarium was sent on loan to Mr. R. D. Hoogland (then a senior student of Dr. Lam) in connection with his study of the *Dilleniaceae* of the Malayasian region and adjacent countries. Inadvertently this new species was also despatched to him with other specimens. It is, however, surprising to note that Hoogland suggested his name as the author of the new speies on our sheets, completely ignoring the remarks and entries already made therein by the senior author, pointing out clearly that it is a new species of *Dillenia*, to be named as *D. parkinsonii* Raizada sp. nov. To our knowledge the description of the plant has not appeared so far under Hoogland's authorship and we describe it here.

Our thanks are due to Father H. Santapau of St. Xavier's College, Bombay for the Latin diagnosis of the species.

EXPLANATION OF PLATE

A.—A leafy twig × 1.

B.—Shoot with flower and flower buds × 1.

C.—Stamen × 2.

D.—Carpels × 2.

INDIGENOUS CELLULOSIC RAW MATERIALS FOR THE PRODUCTION OF PULP, PAPER AND BOARD

PART XVI.—CHEMICAL PULPS AND WRITING AND PRINTING PAPERS FROM WATTLE WOODS (*ACACIA DECURRENS*, WILLD. AND *ACACIA MOLLISSIMA*, WILLD.)

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SUMMARY

Laboratory experiments on the production of chemical pulps by the sulphate process from wattle woods (*Acacia decurrens* and *Acacia mollissima*, Willd.) are described. Results of five pilot plant experiments on the production of chemical pulps and writing and printing papers are also included. In the case of three pilot plant experiments, a mixture of equal quantities of the two species of wattle wood was used for the digestion. These wattle woods are short-fibred and, hence, admixture of their pulps with about 40% of a long-fibred pulp such as bamboo pulp is necessary for making paper. Papers made from mixtures of wattle and bamboo pulps prepared under suitable conditions had good formation and satisfactory strength properties. Three samples of papers are appended. One sample is from *A. decurrens*, another from *A. mollissima* and the third from a mixture of the woods of the two species.

INTRODUCTION

Acacia decurrens (green wattle) and *Acacia mollissima* (black wattle) are the two exotic species of wattle raised on the Nilgiris and the Upper Palni hills of Madras State for the valuable tan barks they yield. Wattle bark used to be imported from South Africa. With a view to improving local resources of tan bark, attempts have been made to grow these species of wattle in India, but so far they hold out promise of success only in the two localities mentioned above. According to the Current Working Plans, it is proposed to plant upwards of 15,000 acres on the Upper Palnis (Kodaikanal plateau) and about 6,000 acres on the Nilgiris. In the Nilgiris, there are possibilities of further extending these plantations if the Wenlock Downs R.F. is also planted up.

As per the Working Plan prepared in 1947 by Shri V. S. Krishnaswamy, I.F.S., the whole of the available area in the Upper Palnis is to be planted up in 10 years. Large scale planting was started in 1948 and it is hoped that if the planting programme is kept up, at no distant future, about 1,500 acres of wattle plantations will be available for felling every year. According to present estimates, an acre of wattle plantation 10 years old is expected to yield not less than 5 tons of bark and 20 tons of wood. This will mean that 30,000 tons of wattle wood will be available every year in the Upper Palnis.

On the same basis, the annual cut in the Nilgiris is expected to be about 600 acres, which will yield 12,000 tons of wattle wood per annum.

While small quantities of wattle wood can be disposed of locally as firewood, large scale disposal of the wood will present considerable difficulty. An obvious solution of this problem would be to find an industrial use for wattle wood. Accordingly, an investigation was undertaken at this Institute to ascertain the suitability of the wood for the manufacture of newsprint and writing and printing papers. The results of the investigation on the production of chemical pulps and writing and printing papers are described in this bulletin.

THE RAW MATERIAL

For the laboratory experiments, 14 billets of *A. decurrens* and 10 billets of *A. mollissima* were supplied by the Forest Range Officer, Kodaikanal Range, through the District Forest Officer, Madura. The billets were about 3 feet in length and 6 inches in diameter. The wood was received without bark. The surface of the billets was reddish-brown in colour. The heartwood was reddish-pink and the sapwood light yellow. This wood was used for the proximate analysis and the laboratory digestions.

For pilot plant experiments, the District Forest Officer, Madura, supplied 3 tons each of *A. decurrens* and *A. mollissima*. The supplies consisted of branch and stem wood. The barked billets were about 3 feet in length and 1½–10 inches in diameter. The moisture content of the wood as received was 45%.

PROXIMATE CHEMICAL ANALYSIS

Chips from the wood of each species were converted into dust in the usual way. The dust passing through 60-mesh and retained on 80-mesh was used for the proximate chemical analysis employing the TAPPI standard methods. The results of the analysis are recorded in Table I.

TABLE I

Proximate chemical analysis of A. decurrens and A. mollissima

		% on the oven-dry basis except moisture	
		A. decurrens	*A. mollissima*
1.	Moisture	6·77	6·85
2.	Ash	0·36	0·36
3.	Cold water solubility	1·69	1·61
4.	Hot water solubility	2·26	3·28
5.	1% NaOH solubility	15·64	15·95
6.	10% KOH solubility	28·11	28·51
7.	Ether solubility	0·36	0·16
8.	Alcohol-benzene solubility	1·07	0·60
9.	Pentosans	19·35	20·30
10.	Lignin	21·24	21·17
11.	Cellulose (Cross and Bevan)	63·17	63·95

From these results it is clear that the cellulose content of these species is high enough to warrant the utilization of these woods for the production of papers from the point of view of the yield. The contents of other constituents are also satisfactory for the use of these woods for chemical pulping.

FIBRE DIMENSIONS

The pulps prepared by the digestion of the chips by the sulphate process using 26% of chemicals (on the basis of the oven-dry weight of the chips) in 65 g./litre concentration at 142°C. for 6 hours were used for the measurement of fibre length and diameter by the usual procedures followed in this laboratory. In the case of *A. decurrens*, the fibre length varied

from 0·50 mm. to 1·15 mm., the average value being 0·86 mm. The minimum and maximum values for the fibre diameter were 0·0090 mm. and 0·0240 mm. respectively, and the average value was 0·0140 mm. The ratio of the average fibre length to diameter was 61 : 1.

In the case of *A. mollissima*, the fibre length varied from 0·52 mm. to 1·16 mm. with an average value of 0·70 mm. The fibre diameter varied from 0·0091 mm. to 0·0212 mm., the average value being 0·0142 mm. The ratio of the average fibre length to diameter was 49 : 1.

The fibre length distribution is given in Table II and the fibre diameter distribution in Table III.

TABLE II

Fibre length distribution

Fibre length mm.	Number of fibres		% of fibres	
	A. decurrens	*A. mollissima*	*A. decurrens*	*A. mollissima*
0·5 to 0·6 ..	5	14	2·5	7·0
0·6 to 0·7 ..	14	59	7·0	29·5
0·7 to 0·8 ..	62	65	31·0	32·5
0·8 to 0·9 ..	85	39	42·5	19·5
0·9 to 1·0 ..	28	11	14·0	5·5
1·0 to 1·2 ..	6	12	3·0	6·0
TOTAL ..	200	200	100·0	100·0

TABLE III

Fibre diameter distribution

Fibre diameter mm.	Number of fibres		% of fibres	
	A. decurrens	*A. mollissima*	*A. decurrens*	*A. mollissima*
0·009 to 0·012 ..	93	101	46·5	50·5
0·012 to 0·015 ..	98	83	49·0	41·5
0·015 to 0·025 ..	9	16	4·5	8·0
TOTAL ..	200	200	100·0	100·0

PRODUCTION OF PULP

Several digestions were carried out in the laboratory by the sulphate process using caustic soda and sodium sulphide in the ratio of 2 : 1. In the case of *A. decurrens* the total quantities of chemicals for digestions were varied from 22% to 26% and the temperature of cooking from 142°C. to 162°C. The period of cooking was 6 hours in all the cases. This period includes the time required for the contents of the digester to reach the cooking temperature from 100°C. It took about 30 minutes to raise the temperature to 100°C. from the room temperature.

In the case of *Acacia mollissima*, the total quantities of chemicals for cooking were varied from 20% to 26%. In other respects, the digestions were carried out as in the case of *A. decurrens*.

Air-dry chips (about 200 g.) of about 8% moisture content were used for each digestion. The cooking was carried out in a vertical stationary cast iron autoclave of 3 litres capacity. The autoclave was heated from outside by means of gas burners. After cooking, the pulp was washed on a 60-mesh sieve and bleached with bleaching powder in two stages. In the first stage, about 75% of the total requirement of the bleaching powder was used. After the first stage of bleaching, the pulp was washed and treated with 2% caustic soda (on the oven-dry weight of the pulp) at 70°C. for one hour.

The fully bleached pulp was beaten in the Lampen Mill till the required freeness was obtained. Standard sheets were made. These were tested for strength properties after conditioning at 65% R.H. and 70°F. In the case of sheets from *A. mollissima* pulp, the temperature of conditioning was 62°F.

The digestion conditions, pulp yields, bleach consumption and strength properties of pulp sheets from *A. decurrens* are given in Table IV and similar data for *A. mollissima* in Table V.

PILOT PLANT TRIALS

In order to confirm the suitability of these two species of wattle wood for the production of writing and printing papers, pilot plant experiments were carried out using about 550 lb. of wood chips (on the basis of oven-dry weight). In one experiment *A. decurrens* was used and in another *A. mollissima*. In the remaining three experiments, a mixture of equal quantities of the two species was used since both these species are raised in plantations in the same area. In all the five experiments, a mixture of stem wood and branch wood in the ratio of 1 : 1 was used.

The cooking was carried out in a vertical stationary mild steel digester of the indirect heating – forced circulation type. The capacity of the digester was 100 cubic feet. After the digestion was over, the pulp was washed twice in the digester and finally in the potcher. The pulp was next bleached in the potcher with bleaching powder in two stages. After the first stage of bleaching, in only one experiment the pulp was treated with 2% caustic soda (on the basis of the oven-dry weight of the pulp) at 70°C. for one hour. In all other experiments, this intermediate treatment with caustic soda during bleaching was not carried out.

The bleached pulp was beaten to the required freeness in a beater of 350 lb. capacity at 5% consistency. Beaten bamboo pulp was added in the proportion of 60% wattle pulp and 40% bamboo pulp in one case and 70% wattle pulp and 30% bamboo pulp in all other cases. This addition was made because the wattle pulp was short-fibred. Requisite quantities of rosin size, alum, china clay and/or titanium dioxide were added, and papers were made on the Fourdrinier machine of the pilot plant. The paper machine was worked at its maximum speed of 50 feet per minute. The running of the papers was satisfactory.

The digestion conditions, pulp yields and bleach consumption are recorded in Table VI and the strength properties of papers in Table VII. A sample each of writing (Table VII, Serial No. 2*b*) and printing papers (Table VII, Serial Nos. 1 and 4) is appended in this bulletin.

DISCUSSION

From the results of the laboratory digestions of *Acacia decurrens* recorded in Table IV, it is clear that easy bleaching well-cooked pulps of satisfactory strength properties can be prepared from this species of wood by carrying out the digestion under suitable conditions. Generally, the strength properties decrease with an increase in the temperature of cooking, other conditions being identical. The yields of bleached pulps are quite high compared to bamboo which gives about 40% bleached pulp. The bleach consumption is also satisfactory. In the case of bamboo, about 9% of standard bleaching powder (on the basis of the oven-dry raw material) is required for bleaching the pulp. Under the conditions studied, the digestion of the wood with 24 or 26% of chemicals at 142°C. gives pulp with satisfactory properties. If "overhead" (single stage) digestion is used, bamboo requires to be cooked with about 22% of chemicals (on the basis of the oven-dry material) at 162°C. for 6 hours. Strength properties of pulps from this wood, however, are not as high as in the case of bamboo because the fibres are short and, therefore, blending of this pulp with about 40% of a long-fibred pulp such as bamboo pulp is essential.

The data recorded in Table V indicate that if the wood of *Acacia mollissima* is digested with 20% of chemicals, the requirement of bleaching powder for bleaching the pulp is high. Easy bleaching pulps of satisfactory strength properties can, however, be prepared by carrying out the digestion under suitable conditions. As in the case of *A. decurrens*, the strength properties of pulps decrease with an increase in the temperature of cooking, other conditions being identical. Under the conditions studied, the digestion of this wood with 22 or 24% chemicals at 142°C. gives the best results. Under these conditions, the yields of the bleached pulps are as high as 57·5%.

The results of the pilot plant experiments recorded in Tables VI and VII confirm that easily bleached pulps in yields as high as 56·8% can be prepared from these two species of wattle wood. They also indicate that a mixture of these two species can be pulped together. Because the wood is short-fibred, admixture of its pulp with a long-fibred pulp such as bamboo pulp is essential. The strength properties of papers made from the pulp prepared under conditions given in Table VI, Serial No. 4 are the best on the whole. The yield of the pulp is also the highest in this case but the bleach consumption is more than in other cases, although it is still lower than in the case of bamboo.

It may be mentioned here that the bark of this wood is a waste material after the extraction of tannin. Experiments are being carried out to find out if this waste bark can be utilized for making pulp for admixture with the pulp from the wood.

FEASIBILITY OF COMMERCIAL MANUFACTURE OF WATTLE PAPERS

Wood of broad leaved species is also used for making chemical pulp for the manufacture of writing and printing papers. In a mill in Portugal, unbleached sulphate pulp has been produced for the last 45 years from *Eucalyptus globulus*[1]. The pulp is mostly shipped to Britain where it is bleached and used in admixture with a long-fibred pulp for the manufacture of better class writing and printing papers, which have good bulk.

Some species of *Eucalyptus* such as *Eucalyptus regnans*, *E. obliqua*, *E. eugenioides*, *E. viminalis* and *E. gigantea* are used in Australia for the manufacture of chemical pulps in the production of writing and printing papers[2]. Similarly beech and poplar are used in

PRINTING PAPER

made from a mixture of 70% *Acacia decurrens* pulp and 30% bamboo pulp (*vide* Table VII, Serial No. 1).

WRITING PAPER

made from a mixture of 60% *Acacia mollissima* pulp and 40% bamboo pulp (*vide* Table VII, Serial No. 2*b*).

PRINTING PAPER

made from a mixture of 70% wattle pulp and 30% bamboo pulp (*vide* Table VII, Serial No. 4). The wattle pulp was made from a mixture of equal proportions of *Acacia decurrens* and *Acacia mollissima*.

Germany while chestnut wood is used in a mill at Condat-le-Lardin (Dordogne), France, for chemical pulping after extraction of tannin with water. The sulphate pulp from chestnut is bleached by the Progil process and is used in the same mill for making good quality writing and printing papers after mixing with about 35–40% of a long-fibred pulp like sulphite spruce pulp. The paper is made at a speed of about 150 metres per minute.

Wattle wood should prove a suitable raw material for the production of writing and printing papers in Madras State. As mentioned earlier, about 30,000 tons of the wood should be available at no distant future in the Upper Palnis, if the plantation programme is carried out according to plan. On the basis of 53% yield of bleached pulp, this quantity of wood can yield 15,900 tons of bleached pulp. In other words, this wood is sufficient for manufacturing daily 53 tons of chemical pulp (bleached), on the basis of 300 working days a year.

Wattle wood will be really a by-product of the large scale wattle plantations which are being raised by the Government of Madras for the tanning bark. The wood has no special use after removal of the bark. Only a fraction of the total quantity available will be sufficient to meet the fuel demand of the locality. Hence, this wood should be available at a very cheap rate. According to one estimate, wattle wood from the Government plantations should be available at about Rs. 20 per ton in the Upper Palnis. Considering that wattle wood gives a considerably higher yield of pulp than bamboo or sabai grass and that it should be available at less than one-fifth the price of these commonly used fibrous raw materials, it should be possible to manufacture writing and printing papers at a cheaper price if wattle wood is used as the main fibrous raw material. Besides, chemical pulps from broad leaved woods have certain advantages. For example, they give papers of good bulk, excellent formation and good printability.

CONCLUSIONS

1. Bleached pulps in 53–56·8% yield can be obtained from wattle wood (*A. decurrens* and *A. mollissima*) by the sulphate process. These pulps are, however, short-fibred. The average fibre length of *A. decurrens* is 0·86 mm. and that of *A. mollissima* 0·70 mm.

2. Writing and printing papers can be manufactured from wattle wood pulps. Since these species are short-fibred, admixture of their pulp with about 40% of a long-fibred pulp is necessary in the manufacture of writing and printing papers with satisfactory strength properties.

3. Wattle wood is a by-product of tan bark industry in Madras State. It should be available at no distant future date in sufficiently large quantities to make its disposal a difficult problem, if the plantation programme of the Madras Forest Department is carried out according to plan. Utilization of this wood for the manufacture of writing and printing papers will meet a national requirement.

Thanks are given to Shri V. S. Krishnaswamy, I.F.S., Central Silviculturist, Forest Research Institute, Dehra Dun, for his help in writing the introduction of this bulletin. Thanks are also due to the District Forest Officer, Madurai, for the supply of wattle wood for this investigation.

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TABLE IV.—*Sulphate digestions of the wood from Acacia*

DIGESTION CONDITIONS AND PULP YIELDS

1	2	3	4	5	6	7	8	9
Serial No.	Total chemicals* (NaOH : Na_2S=2 : 1)	Concentration of chemicals	Digestion temperature	Digestion period	Consumption of chemicals*	Unbleached pulp yield*	Bleach consumption as standard bleaching powder containing 35% available chlorine*	Bleached pulp yield*
	%	g./litre	°C.	hours	%	%	%	%
1	22	55	142	6	21·0	58·8	8·9	55·0
2	22	55	153	6	20·7	57·5	7·1	55·0
3	22	55	162	6	21·5	57·5	6·3	53·8
4	24	60	142	6	22·3	58·5	6·8	53·8
5	24	60	153	6	22·4	56·3	7·6	53·5
6	24	60	162	6	22·7	55·0	7·1	52·5
7	26	65	142	6	23·0	59·0	5·9	55·0
8	26	65	153	6	..	56·2	6·6	54·3
9	26	65	162	6	24·6	51·0	6·7	50·0

* The % is expressed on the basis of the raw material (oven-dry).

decurrens and strength properties of standard pulp sheets

STRENGTH PROPERTIES OF STANDARD SHEETS CONDITIONED AT 65% R.H. AND 70°F.

10	11	12	13	14	15	16	17
Freeness of pulp	Basis weight	Breaking length (Schopper)	Stretch	Tear factor (Marx-Elmendorf)	Burst factor	Folding endurance (Schopper)	REMARKS
c.c. (C.S.F.)	g./sq. metre	metres	%			double folds	
330	60·2	8330	4·2	79·2	53·2	330	In Serial Nos. 1-9, well-cooked pulps were obtained. These pulps could be easily bleached to a good white shade.
314	58·1	7670	3·3	70·5	40·3	80	
314	59·0	6920	3·5	68·2	38·9	65	
309	59·5	6080	3·2	58·2	35·9	30	
316	60·4	5680	2·5	58·1	37·1	30	
280	58·8	5960	2·6	51·9	35·3	50	
350	58·4	8470	4·3	90·8	50·7	580	
295	59·6	7050	3·8	68·0	38·1	85	
312	59·2	6920	3·4	54·0	34·9	40	

TABLE V.—*Sulphate digestions of the wood from Acacia*

DIGESTION CONDITIONS AND PULP YIELDS

1	2	3	4	5	6	7	8	9
Serial No.	Total chemicals* (NaOH : Na_2S=2 : 1)	Concentration of chemicals	Digestion temperature	Digestion period	Consumption of chemicals*	Unbleached pulp yield*	Bleach consumption as standard bleaching powder containing 35% available chlorine*	Bleached pulp yield*
	%	g./litre	°C.	hours	%	%	%	%
1	20	65	142	6	19·7	62·5	9·5	60·0
2	20	65	153	6	19·0	60·0	9·8	56·1
3	20	65	162	6	19·4	56·3	8·2	53·8
4	22	65	142	6	19·9	60·0	6·6	57·5
5	22	65	153	6	21·1	57·5	6·6	54·3
6	22	65	162	6	20·7	55·0	7·0	53·7
7	24	65	142	6	22·1	60·5	5·7	57·5
8	24	65	153	6	22·8	56·2	6·0	55·0
9	24	65	162	6	23·1	52·5	6·2	50·0
10	26	65	142	6	22·0	60·0	4·9	56·3
11	26	65	153	6	24·4	52·5	4·9	..
12	26	65	162	6	24·8	52·5	5·0	50·6

* The % is expressed on the basis of the raw material (oven-dry).

mollissima and strength properties of standard pulp sheets

STRENGTH PROPERTIES OF STANDARD SHEETS CONDITIONED AT 65% R.H. AND 62°F.

10	11	12	13	14	15	16	17
Freeness of pulp	Basis weight	Breaking length (Schopper)	Stretch	Tear factor (Marx-Elmendorf)	Burst factor	Folding endurance (Schopper)	REMARKS
c.c. (C.S.F.)	g./sq. metre	metres	%			double folds	
320	58·9	7660	4·3	89·9	45·8	220	In Serial Nos. 1–12, well-cooked pulps were obtained. These pulps could be easily bleached to a good white shade.
320	58·6	6470	4·0	76·8	38·5	110	
290	59·6	6590	3·3	62·0	36·9	60	
330	59·6	6610	4·1	81·0	41·9	110	
305	57·7	6130	3·8	65·7	38·5	60	
310	63·0	5780	3·7	56·6	35·3	50	
280	61·8	7080	3·8	80·1	42·9	220	
310	60·4	7260	4·4	75·3	44·2	130	
300	62·4	6960	3·5	57·6	37·8	50	
330	61·1	6450	3·5	75·3	40·7	75	
330	62·4	6320	3·4	56·7	35·8	35	
280	60·4	6230	3·1	52·9	34·8	35	

TABLE VII.—PILOT

Strength properties of papers from pulps described in Table VI. Serial Nos. in this Table correspond

1	2	3	4	5	6		7		8	
Serial No.	Freeness after the addition of size, etc.	Ream weight 20″×30″—500	Basis weight*	Thick-ness	Tensile strength (Schopper)		Breaking length*		Stretch	
	c.c. (C.S.F.)	lb.	g./sq. metre	mils (1/1000 inch)	kg. breaking strain per cm. width		metres		%	
					Machine direc-tion	Cross direc-tion	Machine direc-tion	Cross direc-tion	Machine direc-tion	Cross direc-tion
1	175	31·2	67·9	4·40	2·53	1·49	3730	2200	1·5	2·9
2*a*	200	29·9	64·9	4·05	2·70	1·34	4160	2070	2·0	2·8
2*b*	160	28·4	61·8	3·80	2·92	1·57	4730	2540	2·1	3·0
3	210	30·7	66·9	4·55	2·66	1·40	3980	2090	1·5	2·6
4	180	30·8	67·2	4·20	3·35	2·28	4980	3390	1·5	3·0
5	250	27·8	60·7	4·90	1·99	1·13	3280	1860	1·6	2·3

* In calculating this, oven-dry weight of the paper was used.

NOTE.—Table VI is on page 538.

PLANT TRIALS

to the Serial Nos. in Table VI. The papers were conditioned at 65% R.H. and 75°F.

9		10		11	12	13		14
Tearing resistance (Marx-Elmendorf)		Tear factor*		Bursting strength (Ashcroft)	Burst factor*	Folding resistance (Schopper)		REMARKS
g.				lb./sq. inch		double folds		
Machine direction	Cross direction	Machine direction	Cross direction			Machine direction	Cross direction	
44	45	64·8	66·3	18·7	19·4	14	10	In Serial Nos. 1, 3, 4 and 5 wattle and bamboo pulps were mixed in the ratio of 70 : 30. Printing papers were made. A sample each from Serial Nos. 1 and 4 is attached in this bulletin.
34	38	52·4	58·6	14·4	15·6	12	5	Wattle and bamboo pulps were mixed in the ratio of 70 : 30. Printing paper was made.
42	45	68·0	72·8	16·9	19·2	26	12	Wattle and bamboo pulps were mixed in the ratio of 60 : 40. Writing paper was made. A sample is attached in this bulletin.
44	46	65·8	64·1	19·6	20·6	12	8	
34	37	50·6	55·1	19·1	20·0	16	7	
34	37	56·0	61·0	12·6	14·6	4	3	

TABLE VI.—PILOT PLANT TRIALS

Sulphate digestions of A. decurrens and A. mollissima and pulp yields

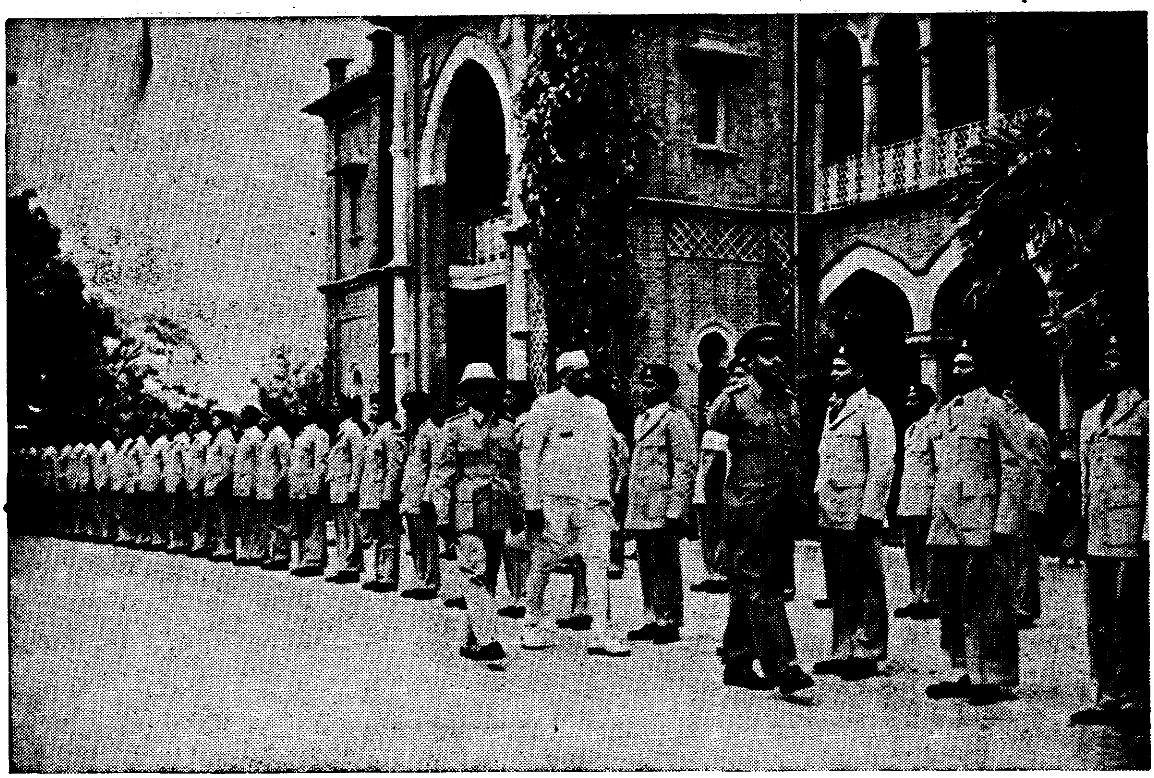
1	2	3	4	5	6	7	8	9	10
Serial No.	Total chemicals* (NaOH : Na_2S=2 : 1)	Concentration of chemicals	Digestion temperature	Digestion period	Consumption of chemicals*	Unbleached pulp yield*	Bleach consumption as standard bleaching powder*	Bleached pulp yield*	REMARKS
	%	g./litre	°C.	hours	%	%	%	%	
1	24	60	153	6	23·2	55·7	6·2	53·0	*A. decurrens* was used. Well-cooked pulp was obtained. The whiteness of the bleached pulp was good.
2	24	60	At 162 for the first 2 hours and 153 for the remaining period	6	21·7	56·0	6·0	54·3	*A. mollissima* was used. Well-cooked pulp was obtained. The whiteness of the bleached pulp was good.
3	22	55	153	6	21·1	56·2	6·5	53·3	In Serial Nos. 3, 4 and 5, a mixture of equal quantities of *A. decurrens* and *A. mollissima* was used. Well-cooked pulp was obtained. The whiteness of the bleached pulps was good. In Serial No. 3, the bleached pulp was taken out in the form of dry sheets before adding to the beater.
4	24	60	142	6	21·3	58·1	8·2	56·8	
5	24	60	153	6	23·0	55·2	6·2	52·7	

* The % is expressed on the basis of the raw material (oven-dry).

MADRAS FOREST COLLEGE, COIMBATORE. CONVOCATION, 1953

The annual Convocation of the Madras Forest College was held on Tuesday the 30th June, 1953 at 11 a.m. in the nicely decorated Assembly Hall. It was a picturesque setting with the Father of the Nation overlooking the hall above the seat of the Chief Guest. The invitees included a large and distinguished gathering of officials and non-officials of Coimbatore and other places. We had the privilege of Shri Sri Prakasa, Governor of Madras, presiding over the Convocation, distributing the certificates, medals and prizes to the successful students of the 1951–53 Ranger Division and the 1952–53 Division of the Regional Foresters School and addressing the Convocation.

The Governor, accompanied by his Private Secretary and A.D.C. and the Collector of Coimbatore, arrived at the College at 10·55 a.m. He was received by the President, Forest Research Institute and Colleges, and the Principal, Madras Forest College and was profusely garlanded by the latter.



The Governor, Shri Sri Prakasa, inspects the Guard of Honour presented by Ranger Students accompanied by Shri M. V. Achar, Officer-in-charge of Guard of Honour.

A guard of honour was presented by the Ranger Classes. Shri M. V. Achar, Asst. Lecturer in Engineering was in charge of the guard of honour. After introduction to the Chief Conservators of Forests of Madhya Pradesh, Madras and Travancore-Cochin, the local Conservators and officers of the College, the chief guest was conducted in procession to the dais led by the Principal, Madras Forest College and followed by the President, Forest Research Institute and Colleges, the Dean, Indian Forest College, and Chief Conservators of Forests of

Madras, Madhya Pradesh and Travancore and Cochin. The President, Forest Research Institute and Colleges welcomed the Governor with the following words :

"Shri Sri Prakasa, Ladies and Gentlemen,

"In opening the proceedings this morning, I have pleasure in extending a warm welcome to all the ladies and gentlemen who are present here to-day. We are especially gratified by the presence of Shri Sri Prakasa, Governor of Madras, who despite the many calls on his time, has very kindly agreed to preside at this occasion and to address the Convocation. We have always been fortunate in being able to persuade eminent leaders to accept the honour and obligations of delivering the Convocation address, both here and at Dehra Dun. Indeed at the last Convocation at Dehra Dun we had the unprecedented and slightly embarrassing situation of two distinguished personages, the Central Minister of Agriculture and the Governor of Uttar Pradesh, being both present and both addressing the Convocation. To-day we are honoured by having with us Shri Sri Prakasa, whose services to the country as statesman, scholar, parliamentarian and patriot are so well known.

Shri C. R. Ranganathan, I.F.S., delivering the Welcome Speech.

"When I started service thirty years ago, people, especially in the towns, were incredibly ignorant about what a forest officer was and what he did to make a living. I remember being introduced to various people, especially ladies, as some kind of a jungle Collector and not, if you please, a jungle Conservator. There was perhaps more truth in this description than one suspected at the time. The role of the forest as a source of public revenue was, it seems in retrospect, over-stressed possibly eclipsing its more basic function as the provider of materials and facilities required by the people and as a bulwark against the erosive and desiccating forces of nature. Indian forestry was, inevitably, a reflection of the methods and aims of

European forestry and the fact that Indian forests which are mainly mixed tropical forests refused to behave like European forests composed of two or three species was for a great many years a source of continual surprise and bitter disillusionment to the Europe-trained officers of the Indian Forest Service. The shibboleths of continental forestry dominated our thinking and were erected into unalterable principles. Thus fire and grazing were always regarded as anathema in the forest in all circumstances. It took very many years of experience and research for forest officers to realize that in certain circumstances fire might be used under control to promote our objects and that in certain other circumstances the rigid exclusion of fire might work to our disadvantage. Forest grazing and lopping of trees were allowed as concessions to be limited, reduced and extinguished as soon as possible. The view of forest grazing as something alien to and incompatible with forestry became gradually modified and in its place the view gained ground that the provision of grazing must be regarded under Indian conditions as a prime object of forest management, however much it might have to be controlled and regulated in order to secure the other object of management.

"Pursuit of the European tradition led also to the neglect of a very important aspect of Indian forestry. Unlike European forests, our forests are the source of an immense range of minor forest products comprising natural drugs, dyes, tans, fibres, flosses, honey, etc. The development of these resources has been taken up comparatively recently.

"The establishment of Indian forestry as an applied science different from and independent of European forestry was effected through a long period of research comprising innumerable experiments and observations. The evolution of the technique of teak regeneration in the moist forests of Madras from an expensive gamble depending on weather and other conditions to something approaching 100% success at low cost is a striking example of the achievements of sustained research. The making of irrigated plantations in Punjab is another such example. Numerous other examples could be cited.

"The activities of the forest officer were, however, by and large limited to the areas declared by law as forests. His relations with the people began when they entered the forest and ended when they left it. His forestry was practised within the confines of reserved and protected forests. Farm-forestry, fodder forestry, wind breaks, shelter belts, etc., on lands outside forests are new ideas to which he has not taken very kindly yet.

"Since the day of independence the notion that forestry is an endeavour to be pursued within the boundaries of legally constituted forests has become obsolete. The meaning of forestry has become enlarged so as to include not only growing trees outside reserved and protected forests, but also the management of all wild vegetation regardless of its legal status. In discharging these enlarged duties, new problems of ecology, silviculture and protection will arise for which solutions will have to be found through planned and sustained research.

"As one who is more or less acquainted with the forestry situation in most States, I am left with a feeling that our research activities have lost both their edge and their tempo, and that they are imperfectly geared to the current problems. As a sign of this, I may say that the flow of articles on Forestry topics to the "Indian Forester" has now dwindled to a thin trickle. At one time, we were in a position to pick and choose from the contributions and reject all but the best.

"If India is to retain her position as a leader in tropical forestry and if we are to solve the numerous new problems connected with the emergence of forestry as an active force in the rehabilitation of village lands and in soil conservation work, it is essential that research and development work should be re-organized and that it should not be starved for want of staff or money. Research has always been the spear-head in the progress of Indian forestry and in the new conditions that face us to-day the need is for more and not less research.

"I do not wish to take up your time by going into details of the training of the students who are passing out to-day, but I might perhaps draw attention to the fact that in August last we started a regional school for training foresters for the southern region and that the first batch of students from that school is completing the course to-day. It only remains for me to wish the outgoing students the very best of luck in their chosen careers and to hope that their future service will reflect nothing but credit to the College which has trained them.

"I will now ask the Principal to present his report".

Messages wishing the function success received from Shri P. S. Deshmukh, Minister for Agriculture to the Government of India, Shri K. M. Munshi, Governor of Uttar Pradesh, Dr. Kailas Nath Katju, Minister for Home Affairs and States, Government of India, Shri C. D. Deshmukh, Minister for Finance, Government of India, Shri K. C. Reddy, Minister for Production, Government of India, Shri V. V. Giri, Minister for Labour, Government of India, Shri C. C. Biswas, Minister for Law and Minority Affairs, Government of India, Shri K. Hanumanthiah, Chief Minister, Mysore State, Shri A. J. John, Chief Minister, Travancore and Cochin, Shri Shambhu Nath Shukla, Chief Minister, Vindhya Pradesh, Shri C. M. Poonacha, Chief Minister, Coorg, Shri C. Coomaraswamy, High Commissioner for Ceylon in India, Dr. M. V. Krishna Rao, Minister for Education, Government of Madras, Shri Rajah of Ramnad, Minister for House Rent Control, Government of Madras, Shri B. S. Hiray, Minister, Government of Bombay, Shri Dan Bahadhur Singh, Minister for Forests, Government of Madhya Pradesh and the Chief Conservators of Forests, Bombay, Hyderabad and Mysore were read. Shri M. D. Chaturvedi, the Inspector-General of Forests, who was expected to be present at the Convocation had to stay away unavoidably at Dehra Dun in connection with the visit of the parliamentary committee to the Forest Research Institute and Colleges, and could not thus attend the function. He had, however, sent a message expressing extreme regret for his absence and conveying his best wishes to the outgoing students, and gratitude to the Governor for gracing the occasion.

The Principal, Madras Forest College, Shri Y. M. L. Sharma, next presented the following report and announced the results of the 1951–53 Ranger Division and the 1952–53 Forester Division of the Regional Foresters School.

"Mr. President, Ladies and Gentlemen,

"I beg leave to present my report on the working of the College during 1952–53. The College continued to train Rangers as in the previous year. A Regional Foresters School was sanctioned by the Government of India as part of the College for training foresters deputed by the South Indian States. Thus the first batch of foresters commenced their course on 16th August 1952. We are sending out to-day, to the various States of India (Vindhya Pradesh, Hyderabad, Coorg, Madras) and Ceylon 34 trained Rangers and to Mysore, Madras and Travancore and Cochin States 20 trained Foresters.

2. *Strength of the College*—The total number of students in the College during the year was 93.

Rangers :—

(i)	*Senior Division (1951–53 Course)* :	
	Madras	19
	Hyderabad	8
	Ceylon	4
	Vindhya Pradesh	2
	Coorg	1
	TOTAL	34
(ii)	*Junior Division (1952–54 Course)* :	
	Madras	18
	Hyderabad	8
	Ceylon	6
	Madhya Pradesh	4
	Vindhya Pradesh	2
	Cultural Scholar from British Guiana sponsored by Government of India	1
	TOTAL	39

Foresters : 1952–53 Course :

Madras	15
United State of Travancore and Cochin ..	4
Mysore	2
TOTAL	21

One student was subsequently withdrawn by the Government of Madras. Thus the final number of foresters passing out to-day is 20.

3. "*The Course*—The course for Rangers is similar to that at Dehra Dun with slight modifications in tours to suit local conditions. The approved syllabus for the Regional Foresters School is in conformity with that of similar schools in Madhya Bharat, Madhya Pradesh and other States. Special emphasis is, however, laid on the working of the forests of the deputing States. In both these courses the practical aspect of forestry training is given the greatest importance.

"All classes had lectures and practical work in forestry and allied subjects at headquarters. Saturdays were usually devoted to field work, like sowings and plantings in the estate, or visits to places of forestry and allied interest in and around Coimbatore.

"*Tours*—The Senior Rangers toured in the forest divisions of the States of Mysore, Madras, Madhya Pradesh and Hyderabad. The Junior Rangers toured in the forest divisions of Madras and Coorg. The Regional Foresters School toured in South and North Coimbatore, Palghat, Wynaad, Tiruchirapalli, Nilambur and Nilgiris Divisions of Madras and Coorg. A large number of topics were studied and practical work done on all these tours. I am grateful to all the heads of the forest departments, to the concerned District Forest Officers, to the transport agencies and their staff for the unfailing co-operation extended to the classes on these tours. The Rangers passing out to-day underwent a course in Field Engineering and training in marksmanship extending over 3 weeks with the H.Q. Corps of Engineers at Bangalore. I am grateful to the Commandant Col. Shumshere Singh for the excellent facilities afforded to us while at Bangalore.

"The Regional Foresters School had a course of musketry training in the Police Recruits School at Coimbatore. I am grateful to the Government of Madras, to the Collector of Coimbatore and to the Police Department for their gesture in agreeing to give this training for the students.

"I am glad to announce that Shri K. Velayudhan Nair of Senior Ranger Class and Shri M. K. Subramanyam of Regional Foresters School have won the two first prizes in their classes in shooting.

4. "*Physical training, Games and sports*—Physical Training in the mornings and games in the evenings were compulsory at headquarters. These have contributed largely for better physical standards so essential for forest life. On account of these regular habits the general health of students remained satisfactory. I am grateful to Shri K. Kurup, Retired Judge, Coimbatore for his continued keen interest and liking for our method of training and again donating a prize for the most physically fit and healthiest student during the year. This prize has been awarded to Shri R. S. Tiwari of Vindhya Pradesh.

"The annual Marathon race was run for all students including those of the Regional Foresters School. I am glad to state that A. Eswarappa (Mysore) of the Regional Foresters School won the race completing the track of 7 miles in 47 minutes and $30\frac{4}{5}$ seconds.

"The annual athletic sports were held in November 1952 amidst colourful atmosphere. The Richmond Cup for the highest number of points scored in the annual athletic sports, as champion athlete of the year was won by Shri M. P. Belliappa (Coorg) and the Pentland Shield as alround sportsman by by S. Devarajulu (Madras). The presence of Shri M. D. Chaturvedi, Inspector-General of Forests and Shri S. D. Udhrain, Under Secretary for Ministry of Food and Agriculture, Government of India in addition to the local dignitories was a feature of this year's sports.

"The inter-divisional tournaments were held as usual and I am glad to announce that the Junior Division did very well in these.

"The swimming test was conducted at Nedungayam (Nilambur Division) for all the students passing out to-day. I am glad to announce that Shri B. P. Pandeya (Vindhya Pradesh) of Senior Ranger class and Shri K. Sreedharan Nair (United State of Travancore-Cochin) of Regional School came first in their respective classes, and have won the two prizes for swimming.

5. "*Common Mess*—Common messes were run separately one for Rangers and another for Foresters. These continued to work efficiently promoting a spirit of tolerance and mutual understanding amongst the members.

6. "*Extra-curricular activities* – (*i*) *Lectures on Wild-Life*—A course of lectures on Wild-Life was delivered during the year by Shri D. N. Neelakanta Rao, Retired Game Preserves Officer, Mysore, for all the three classes in session. The Rangers visited the game sanctuaries of Periyar, Mudumalai and Khana on their tours and studied their maintenance and methods of *shikar* in addition to elephant capture.

(*ii*) "*First Aid*—All students passing out to-day attended a course of first aid to the injured. The successful candidates have been awarded the certificates of St. John Ambulance Association. I thank Captain K. V. Madhavan Nair, Medical Officer, Lawley Road, Dr. P. K. Warrier, of the Government Headquarters Hospital and the District Medical Officer, Coimbatore for the conduct of the examination.

(*iii*) "*Students Library and Literary Association*—A number of new books were added to the library during the year. The field engineering work at Bangalore, the visit to the Khana Sanctuary in Madhya Pradesh, the tour of the Seniors in the teak forests of Nilambur, the convocation and annual sports 1952 were filmed during the year. It is hoped that in due course the literary club would have a more or less complete documentary of the activities of the College at headquarters and on tours.

(*iv*) *Audio-visual aid*—Sound and silent films of educational value loaned from the Information Services in India, Forest Research Institute and Colleges, the F.A.O. and Burma Shell were frequently exhibited to the students, staff and residents of the estate as part of audio-visual aid in scientific education. The College owns a sound film projector for this purpose.

(*v*) "*College Magazine*—The College Magazine continued its publication as a quarterly issue. The editorial board is pleased to place before you to-day the July 1953 issue devoted to articles on 'Wild-Life'. We are extremely grateful to His Highness the Rajpramukh of Mysore, Shri Dharmakumarsinghji, Shri E. P. Gee of Assam, Shri S. D. Udhrain and other high officers and public men interested in the subject for contributing articles to the issue. I hope the magazine which is entering into its 6th year after reopening of the College, will continue to be patronized by all concerned in future years as well.

7. "*The College estate* – (*i*) *Buildings*—Ordinary repairs to the College and other residential buildings were carried out by Central P.W.D. during the year. The sports pavillion was extended by the Athletic Club prior to the annual sports with a verandah on each of the northern and southern sides. This has resulted in increased efficiency of the building. The athletic flag mast was reinforced with a concrete pillar at its base.

(*ii*) "*Water-supply*—Acute shortage of water was felt during the past two years due to lack of rain. The two rain-water tanks on either side of the main building were serviced. The College well which had gone dry was deepened during the year. This resulted in a fair amount of water-supply to the nurseries and gardens since the last three months. Shortage of water for drinking, cooking and other purposes for the residents of the estate as well as for students is still keenly felt due to the limited supply of Siruwani water. I appeal to the Coimbatore Municipality to reconsider their recent resolution and accede to our request for an increased quota of Siruwani water, immediately their duplication main is completed.

(*iii*) "On 3rd July 1952, Shri B. Ramakrishna Rao, Chief Minister of Hyderabad inaugurated the *Vana Mahotsava* amidst a distinguished gathering. A number of demonstration plots were formed during the year on the western side of the estate for training students in sowings and plantings with good results.

(*iv*) "*Nursery*—A large nursery for raising planting stock and for purposes of training students was continued to be maintained. Free supply of seedlings of locally useful tree species to the public will be undertaken if required.

8. "*Gass Forest Museum*—The Museum continued to attract many visitors including students of educational institutions from outside Coimbatore. A number of specimens received from different forests of India were added on to the museum during the year. I would like to renew again my request for despatch of exhibits to the museum by forest and other officers and public.

9. "*Training of cultural scholars*—The College continued to train cultural scholars sponsored by the Government of India. We have amidst us Shri C. A. Persaud who joined the 52–54 Course for Rangers from British Guiana. Another candidate Shri Danial Midholi from East Africa has also arrived to join the 53–55 Course on 1st July 1953.

10. "*Visit of distinguished personnel*—The High Commissioner for Ceylon in India His Excellency Shri C. Coomaraswamy, Shri and Shrimati Nagan Gowda, the Chief Conservators of Forests, Madras and Bombay, the Inspector-General of Forests and the Under Secretary to Government of India Shri Udhrain, F.A.O. scholars from Thailand, Shri Hejmadi, Famine Commissioner and Lt. Col. Henchy, Commandant of the Training Battalion of the H.Q. Corps of Engineers, Bangalore, some members of the estimates committee of the Indian Parliament were some of the distinguished persons who visited the College and the museum during the year.

11. "*Staff*—Shri K. K. Nair who was District Forest Officer, South Coimbatore joined the College as Instructor in the Rangers Wing in August 1952.

" Shriyuts V. M. Narasimhan and T. K. Rajagopalan of the Madras Forest Department joined on the staff of the Regional Foresters School. Both these have now expressed their desire to revert to their State, at the end of their deputation period and are awaiting orders. In them we lose two good sportsmen and on behalf of my colleagues and myself I wish them best of luck in their future career.

"I also thank all my staff, gazetted as well non-gazetted for the unstinted co-operation extended to me in the successful working of the College during the year.

12. " *Examinations and results*—The half yearly, first year and final examinations were conducted besides examinations at the end of each tour. External examiners were appointed from amongst senior serving forest officers of different States for first year and final examinations. I am indebted to all these for acting as examiners amidst their multifarious administrative duties.

" *Results*—All the 34 students of the Senior Ranger class and 20 students of the Regional Forester School appeared for the final examination.

The results are as follows :—

Rangers :

1.	Honours Certificate	2
2.	Higher Standard Certificate	32
3.	Lower Standard Certificate	Nil

Regional Foresters School :

1.	Honours Certificate	1
2.	Higher Standard Certificate	18
3.	Lower Standard Certificate	1

13. " *Research*—The establishment of the Forestry Research wing at Coimbatore is long overdue and it is hoped that this subject which is already under consideration of the concerned authorities would materialize during the year.

14. " *Conclusion*—Before I proceed to announce the results, permit me, Sir, to address a few words to the outgoing students.

" During your two years' stay in this institution every endeavour has been made to inculcate in you a sense of discipline, spirit of tolerance and acclimatisation to varied conditions of hard life, besides regular training in forestry and its allied branches. Maintain these regular and active habits, cleanliness and smartness in your future career be it at home or outside.

" On you depends the future of the vast forest resources of our country and the direct task of improving them. Do, therefore, the best you can and struggle hard to promote the love of men for the trees around, to stop indiscriminate clearing of vegetation, and to protect the pastures. If each one of you contribute your might to combat this menace with the enthusiasm, strength and hard work necessary, there is no doubt of our success in the preservation and improvement of these national assets. Carry, therefore, the message of love for trees to every hearth and home you come across and prove worthy of your Alma Mater and the training you have received.

"On behalf of my colleagues and on my own behalf I wish you success and happiness in your future life.

"I now request you, Sir, to kindly distribute the certificates and prizes".

The Governor distributed the certificates and prizes to the successful students, as their names were announced by the Principal. He then delivered the Convocation Address as follows :—

Speaking for an hour ex-tempore, the Governor said the very word "forest" or "vanam" raised in our minds many emotions, for it was connected in our history, in our culture, tradition and legends with many things. In fact, forests stand for everything that we hold dear and in which we might take legitimate pride even to-day. Forests in India, he said, had been preeminently the seat of learning where our great literatures and philosophers went for writing their books and thinking of mysteries of life and death. The forest was also the refuge of the

unhappy. It was the seat of our universities and was also the home of our heroes. It was the forest that gave us our medicines, our variegated wild-life, our materials for building and for clothing, our food and all that we needed and admired. Many of us might perhaps recall the great welcome that the *Vana Devatha*, the goddess of forests extended to Sri Rama when he was there in his exile. "You are free", she said to Sri Rama "in these forests to take and taste anything you desire. Here you have fruits and roots in plenty. You will have water and you should not regard yourself as being dependent on anything in this great place". After expressing gratitude for the privilege he had been given to associate himself with this function to-day, Shri Sri Prakasa said that those who were passing out of this institution to-day were dedicated to the preservation of our forest wealth and to serve all that forest stood for.

During the fifteen months he was in Assam, it was his good fortune, he said, to see forests in all their grandeur, their beauty and even their danger and since then forests had instinctively attracted him. After referring to the chequered history of the College which started in 1912 was closed down in 1939 at the time of the war, on account of financial stringency, the Governor said that it was regrettable that while the Government had plenty of money for war, they had very little for purposes of social welfare. Nations spent eighteen crores of rupees per day in last war in mutual slaughter but could not run institutions like this. The College vindicated itself and was reopened in 1945 because the Government could not do without it. In 1948 it was taken over by the Government of India. He expressed the hope that this College would have ever-lasting life and would always be fostered by both Central and State Governments so that the very useful work it was doing might never suffer.

Continuing Shri Sri Prakasa said that there were many things that attracted him to them. First, their number was small. While they were only 93, other educational institutions had thousands on their rolls. And these 93 represented all parts of the country from Vindhya Pradesh to Coorg. And secondly they had a very short course of only two years. In other institutions the students poured miserably over books and struggled hard for years on end and had the look of anxiety on their faces because they did not know about their future. Here they knew exactly what they had got to do after getting their certificates. Employment waited for them. This was the first time that he presided over a Convocation where no degrees had to be given *in absentia*. Looking round the walls, the Governor said, he was happy to note there were no portraits of persons who had nothing to do with the institution itself excepting that of the Father of the Nation who was above everyone and whose portrait must adorn the walls of every institution as it must be enshrined in the hearts of everyone of them.

Referring to the syllabus, Shri Sri Prakasa said it made them know exactly what they wanted to do in life unlike the syllabusses in other institutions which made them think why they had been educated at all. They did not wobble or think of this or that profession as being better than the profession for which they had been educated. Further, they received practical training which very few receive in the ordinary schools and Colleges to which they belonged. Referring to the rifle practice they had received, the Governor said that many persons who wanted to use their guns did not know exactly in what part of the animal's body they should shoot in order to give the best results.

He had received complaints of how villagers having licences of guns, misused them and instead of protecting their fields from the incursions of wild animals went out into the neighbouring forests where they had no business to go and wounded ten deer before they were able to kill one and sometimes put their bullets in the wrong place of the large body of the elephant with the result that with the pain caused, it became wild and rogue. In India it was very necessary that all who could manage it should have a gun on their shoulders and should know how to use it too. Bernard Shaw said that when man killed tiger he called it sport but when tiger killed man he called it ferocity. But they had all got to live. It was true that since the

British had gone animals had come to know, for they also had brains to understand these things, that there were no persons who would kill them. For, our own officers were either averse to killing or afraid of facing wild animals with the result that tigers both in Assam and Madras were rather prowling dangerously near human habitations and what was sport for man before was becoming sport for them to-day. He was, therefore, very happy that they were all taught the very necessary art of being able to shoot and shoot well! If large numbers of our people had the art that they were taught, animals would keep to their own native haunts. He congratulated them also on being taught how to keep healthy and physically fit and in first aid methods. They had also their literary activities so that he realy wanted to know what more they could want. He was only sorry that he was not forty years younger to be in this College and get all that they had got. If the world wanted one thing, it was MEN. Hundreds of millions of human beings wandered over the earth, but few out of them were real men and he was happy that their College at least aimed at creating men. And in the present set-up of our *swaraj*, when our freedom is only four years old, we need men very badly so that they could take up all departments of the nation's activity and bring honour to it. They came from all over the country and even outside like Ceylon and even British Guiana and East Africa had not been unrepresented. This showed what great reputation they carried and that added to their responsibilities so that they might keep that reputation untarnished. He was glad to find that their physical endurance was very great as could be seen from the results of their seven-mile Marathon race. He hoped that while they could run on plain ground they could also run up trees for that would be helpful in forests when neither gun nor their wits would help them. He felicitated them for all the opportunities they had got in these two short years and he had no doubt that they would utilize all the knowledge they possessed to the best purpose.

Coming next to the problem of forests itself, in India, the Governor said they had less than 20 per cent of the surface that was covered by forests. The Government's target was that they should have 33 per cent of our land surface covered with trees. And they had assigned varying proportions to varying tracts of our land from 60 per cent in mountainous regions to 20 per cent in bare plains. They could see what tremendous responsibility rested upon their shoulders to make it possible that the wishes of experts at Delhi might be satisfied so that they might be able to bring from 18 per cent to 33 per cent of our land under the shade of tree. For this, many things were necessary. It would be unfair on his part to put the whole responsibility for the consumation of their hopes on untried shoulders of youngmen who were leaving this institution to-day. Nothing could be done in this world unless there was full co-operation from the general mass of people. It was up to every single one of us to see to it that nothing was done that would denude the landscape of its trees. Deforestation is a great danger. Those of us who know anything about these things go even so far as to say that cutting down of trees has interfered with rainfall to a considerable extent. And in my home State of Uttar Pradesh, they were seriously concerned with the fast approaching desert of Rajasthan that is invading our State at the rate of one mile a year and earnest efforts are being made there in order to stem this dangerous march by the planting of trees. The Governor said in Ootacamund where hundreds of thousands of Eucalyptus plantations had prospered for the last eighty years and more they found a great deal of deforestation going on which was not only destroying the beauty of these lovely hills but was also causing obstructions of various sorts including the possibility of disturbed rainfall. They knew that potato became valuable in war and people were tempted to cut down these beautiful trees in order to get the space for cultivation of this vegetable and as potato had paid well the tendency had grown that more and more land should be under cultivation of potatoes even if that meant destruction of the old blue-gum trees. This was a sacrilege which had been perpetrated by those who lived on these hills. It will be your task and mine, he said, to see to that this is stopped and that people are

trained to understand the wrong they are doing to themselves. In that our *alumni* can help. When you go out, you can tell people that they are in the long run harming themselves by harming trees. And I can tell you that our villagers are very intelligent people and once they understand a thing they adhere to it more strictly than we do. If you are able to explain with all the knowledge and experience that you possess that destruction of trees is a crime against god and man, I am sure you will find the needed response from them. I understand from the authorities of your College too that our growing population and our growing needs are mainly responsible for this widespread destruction. Shri Sri Prakasa said that legislation in this matter could not help much if the general mass of people would not obey it. Proper education must be given to the people and there was no better educator than one who himself had had personal experience of what he should teach. They should inculcate in the minds of our people the desirability of always planting a tree if not more, in place of everyone that they had destroyed. We should enjoin in it on the people as a religious duty and could be sure we shall get the necessary response.

The Governor next said that our people should be encourged to take to what is called *kumri* cultivation under which cultivator was assigned certain acres of land where he carried on his cultivation and was also expected to plant trees and take care of them and after these trees had grown up and no further cultivation was possible he was allotted other pieces of equally useful land where he could repeat this process. He hoped the students would regard it as one of their duties to encourage the cultivators to take to this system of *kumri* cultivation. They were on the eve of the *Vana Mahotsava* week and in that great festival, they must all help. It must not be merely showy sort of thing. It was very necessary that these plants were taken care of afterwards. Accordingly to our ancients one of the duties of the householder was to plant trees. He was expected to dig wells, to erect tanks and plant trees. He hoped that all of them who were passing out would make it a point that they helped in planting of more and more trees and bringing under shade larger and larger areas of our land.

Concluding, the Governor said that those who were leaving the institution to-day deserved their thanks for having undertaken a line of activity that unfortunately did not attract the majority of our people. He should like to offer them his congratulations on the success of their mission. A great thing about their College was that everyone of them passed. They had prepared themselves well for the life that awaited them and they had his best wishes as well as those of the staff. He could not do better than underline the exhortation that their Principal had made to them while reading his report.

In the absence of Shri M. D. Chaturvedi, Inspector-General of Forests, Shri V. V. Subramanian, I.C.S., Chief Conservator of Forests, Madras, proposed the Vote of Thanks. The proceedings came to a close with the singing of the National Anthem by the students.

The Governor was entertained at a well got up dinner in the night in the College by the President, Forest Research Institute and Colleges, and the members of the staff of the Forest College. The guests included the Chief Conservators of Forests of Madhya Pradesh, Madras, Travancore and Cochin and Conservators besides the high district officials in Coimbatore.

On 1st July, 1953 the Governor visited the College at 8 a.m. and inaugurated the fourth *Vana Mahotsava* by planting a sapling of *neem* and another of *Peltophorum ferrugineum*. This was followed by the other officers, ladies and students assembled there. Over 300 plants were planted in ideal planting weather around the Students' Club that day.

After planting the sapling, the Governor recalled how some years ago their former Union Food and Agriculture Minister, Shri. K. M. Munshi, thought of having the annual festival in honour of trees. It was a pity that most of them who dwelt in the towns had forgotten the value of trees and, therefore, they had been neglecting them. Among many causes that had

led to the destruction of a great deal of our forest wealth was that with the growth of so-called civilization they had been flooding their houses with a great deal more of furniture than was necessary, the Governor said. While even in the old palaces of kings, they did not find much woodwork and very little furniture, now-a-days even ordinary middle class homes contained a large number of sofas, tables, chairs and so on, all of which were made of wood and, therefore, trees had to be felled in order to supply their needs. In the olden days they used to sit on floors and work without tables or chairs. The grandfather of the present Maharaja of Banaras, Shri Sri Prakasa said, used to have only one carpet in the whole of his palace and wherever the speaker saw him, he saw the same carpet taken from one room to another and spread out. They had now too much furniture. They should raise a cry against this useless mass of furniture that seemed to encumber their homes.

To-day in inaugurating this tree festival week they worshiped the Goddess of forests and the great wood nymphs, who were famous in the legends of the West as well. "I do hope", the Governor said, "that to-day all over the country millions of new trees would be planted and what is more I hope they will live. Our experience in Ooty has been that only about 50 per cent of the trees survived. Here, I am sure, every sapling planted will survive because you know the art of preservation very much more than laymen".

The Government of India, the Governor said, had particularly recommended the *babul* tree for planting to-day. Other trees recommended were *neem*, bamboos, etc., and he was sure they would be planted wherever they could grow.

Concluding, the Governor said he was happy to visit this great institution of theirs and he hoped it would prosper and with the services it would render the target of the Government of India, namely to cover one-third of our surface with wood, would be fulfilled.

The Governor, accompanied by his Military Assistant, left by car for Ootacamund.

FINAL RESULTS

1951–53 RANGERS COURSE

Serial No.	Name of Student	State	Serial No.	Name of Student	State
In order of merit—			16	M. P. Belliappa	.. Coorg
HONOURS—(75% and over)			17	K. R. Koteswara Rao	.. Hyderabad
1	M. K. Narayanan Nair	.. Madras	18	C. Buysor Ranchigode	.. Ceylon
2	T. C. Ramakrishna	.. Hyderabad	19	M. Manamohan	.. Madras
HIGHER STANDARD (50% to 74%)			20	M. P. Karuppiah	.. Madras
			21	S. Krishnamurthy	.. Madras
3	M. V. Balakrishnan	.. Madras	22	P. Lakshma Reddy	.. Hyderabad
4	B. P. Pandeya	.. Vindhya Pradesh	23	Allam Raja Reddy	.. Hyderabad
5	R. Ponnampalam	.. Ceylon	24	K. Nagarajan	.. Madras
6	K. Velayudhan Nair	.. Madras	25	Syed Durwesh Mohideen	.. Madras
7	Tirmal Rao	.. Hyderabad	26	S. Srinivasa Rao	.. Madras
8	E. Venkat Reddy	.. Hyderabad	27	Md. Sultan Mohideen	.. Madras
9	R. S. Tiwari	.. Vindhya Pradesh	28	B. A. Mohammad Ishaqh	.. Madras
10	G. Samuel	.. Madras	29	K. Ramakrishna	.. Hyderabad
10	R. Balaji Singh	.. Hyderabad	30	M. Radhakrishnan	.. Madras
12	M. Ranganathan	.. Madras	31	V. S. V. Suryanarayanamurthy	Madras
13	T. Yuvaraj	.. Madras	32	K. Sankaran Unni Nayar	.. Madras
14	K. Ramankutty Nair	.. Madras	33	S. Velayudhan	.. Madras
15	Sam S. Perera	.. Ceylon	34	E. D. Cotelingam	.. Ceylon

PRIZES AWARDED TO THE 1951–53 RANGERS COURSE

Serial No.	Name of prize	Name of prize winner	State
1	HONOURS GOLD MEDIAL—(to the student who gets the highest total number of marks and honours).	M. K. Narayanan Nair	Madras
2	COLLEGE SILVER MEDAL—for Forest Utilization	G. Samuel	Madras
3	COLLEGE SILVER MEDAL—for Botany	T. C. Ramakrishna	Hyderabad
4	COLLEGE SILVER MEDAL—for Range Administration	T. Yuvaraj	Madras
5	THE CAMPBELL WALKER PRIZE—for Forestry	M. V. Balakrishnan	Madras
6	THE BRAZIER PRIZE—for the best outdoor Ranger	B. P. Pandeya	Vindhya Pradesh
7	THE LODGE PRIZE—for Forest Engineering	T. C. Ramakrishna	Hyderabad
8	THE KURUP'S PRIZE—for the healthiest student during the year.	R. S. Tiwari	Vindhya Pradesh
9	THE PRINCIPAL'S PRIZE—for musketry training	K. Velayudhan Nair	Madras
10	THE PRINCIPAL'S PRIZE—for Swimming	B. P. Pandeya	Vindhya Pradesh

FINAL RESULTS

REGIONAL FORESTERS SCHOOL, 1952–53 FORESTERS COURSE

Serial No.	Name of student	State
In order of merit—		
HONOURS—(75% and over)		
1	K. R. Srinivasan ..	Madras
HIGHER STANDARD (50% to 74%)		
2	P. K. Philip ..	Travancore and Cochin
3	G. Pullayya ..	Madras
4	K. Sreedharan Nair ..	Travancore and Cochin
5	V. Raju Naidu ..	Madras
6	P. T. Thomas ..	Travancore and Cochin
7	S. R. Balakrishnan Nair ..	Travancore and Cochin

Seriol No.	Name of Student	State
8	M. Sarvagnamurthy Rao ..	Madras
9	M. Mallayyan ..	Madras
10	V. Gopalakrishnamurthy ..	Madras
11	K. Venkateswarulu ..	Madras
12	R. Subramanian ..	Madras
13	P. John Bright ..	Madras
14	A. Eswarappa ..	Mysore
15	Syed Burhanuddin ..	Madras
16	A. Meera Mohideen ..	Madras
17	S. G. M. Hussaini ..	Madras
18	V. Mayandi Thevar ..	Madras
19	M. K. Subramanian ..	Madras
LOWER STANDARD (Below 50%)		
20	J. V. Krishnamurthy ..	Mysore

REGIONAL FORESTERS SCHOOL

PRIZES AWARDED TO THE 1952–53 COURSE

Serial No.	Name of prize	Name of prize winner	State
1	HONOURS MEDAL—(to the student who gets the highest number of marks and honours).	K. R. Srinivasan	Madras
2	SILVICULTURE PRIZE	G. Pullayya	Madras
3	FOREST UTILIZATION PRIZE	K. Sreedharan Nair	Travancore and Cochin
4	BOTANY PRIZE	P K. Philip	Travancore and Cochin
5	FOREST ENGINEERING PRIZE	P. K. Philip	Travancore and Coehin
6	PRACTICAL FORESTER PRIZE	G. Pullayya	Madras
7	PLANTATION PRIZE	A. Eswarappa	Mysore
8	THE PRINCIPAL'S PRIZE—for musketry training	M. K. Subramaniam	Madras
9	THE PRINCIPAL'S PRIZE—for Swimming ..	K. Sreedharan Nair	Travancore and Cochin

SPORTS AND ATHLETICS (RANGERS AND FORESTERS)

1	THE RICHMOND CUP—for the best sports athlete ..	M. P. Belliappa (Coorg).
2	THE MANNARGHAT MOOPIL NAIR CUP—for Marathon Race	A. Eswarappa (Mysore).
3	THE PENTLAND SHIELD—for the best all-round sportsman in the College during the year ..	S. Devarajulu (Junior Division) (Madras).
4	THE FISHER CUP—for Tennis Singles	
	Winner	S. Harold Sundar Issac (Hyderabad).
	Runner	K. R. Koteswara Rao (Hyderabad).
5	Tennis Doubles	
	Winners (2)	S. H. Issac (Hyderabad) and T. C. Ramakrishna (Hyderabad).
	Runners (2)	E. D. Cotelingam (Ceylon) and M. J. Raghavendra Rao (Madras).
6	Tennis Doubles Handicaps	
	Winners	Bhoja Shetty and S. H. Issac.
	Runners	Narasimhan and Sam S. Perera.
7	AMIR MUHMAD KHAN CUP—for the best all-round division in the Marathon Race—Forester Division ..	A. Eswarappa.
8	COWLEY BROWN CUP—for Inter-Divisional Hockey —Junior Division	Manamohan Arjaria.
9	MUMTAZ CUP—for Inter-Divisional Cricket—Junior Division	E. P. De Silva.
10	UBEROI CUP—for Inter-Divisional Volley Ball—Junior Division	P. K. Naik.
11	VEERA PAMPHOI CUP—for Inter-Divisional Foot Ball ..	S Devarajulu (Junior Division).

UTILIZATION OF WASTE WOOD FOR BOARD MANUFACTURE

BY K. P. KARAMCHANDANI, B.SC., A.I.F.C., M.S. (N.Y.S.C.F.)

INTRODUCTION

One of the most important problems of to-day is this conservation of the natural resources and making every ounce of raw material play its part. This is more so in the lumber industry where, for centuries man has been abusing the nature's bountiful but exhaustible supply of timber. It is of common knowledge to all of us that in the course of transfer from the forest to the saw-mill and from the saw-mill to the industrial use, vast quantities of wood waste are accumulated and put to little useful purpose. One authority (1) has estimated that considering a tree as 100% volume of wood, there is an approximate loss of 38% of wood by the time the tree is limbed and bucked into logs, a further loss of 14% during the bark and side slab operations, and an additional loss of 14% by the time the rough lumber is refind to its various commercial stages such as mill work, flooring, cabinets, furniture, etc. Thus in all 66% of the original volume is lost in the course of the various operations. In recent statistics published by the Forest Service of the United States Department of Agriculture it is stated (2) that in cutting up a tree for cooperage 72% is wasted, for lumber 68%, for veneer 66%, while for other specialized productions it may run as high as 80%. A total of over 100,000,000 tons of wood per annum in the United States goes as "waste wood".

Most of this so-called "waste wood" is in the form of cull logs, side slabs, edgings, short ends, shavings, saw-dust, etc., but whatever the form, it represents a considerable economic loss and a criminal waste of natural resources. It is to find valuable outlets for this rich material that is of paramount importance to-day. Although it is true that some of this waste wood has been put to certain uses such as fuel for power (and this represents a very insignificant slice of the entire wastage) the users have been more led by the considerations of disposal rather than those of economic and more efficient utilization.

It is, however, gratifying to note that here in the United States the problem has received and is still receiving considerable attention so that many industries faced with this problem have made creditable progress in solving it. Tremendous progress has also been made in this direction during the last seven or eight years in Europe, notably in Germany, Great Britain and in the Scandinavian countries.

In an interesting article in the America's premier barometer, the wall Street Journal of October 4, 1952, R. H. Spring states that back in 1941 it was estimated that half of each Douglas fir log was wasted – and as you all know Douglas fir is the No. 1 wood in the Pacific North West – but to-day the only thing in the log not put to use is its fresh resinous smell. This, of course shows a very healthy trend in more complete utilization of wood – specially the obvious benefits that would be derived from creating a new source of material from the so far waste wood confined to the dumps.

Classification of wood waste—It is difficult to give any definite classification of wood waste as it occurs in innumerable forms, but broadly the following three catagories are well recognizable.—

1. Forest waste in form of cull logs, small logs and branches.
2. Solid wood waste in the form of slabs, edgings, and end trim at the saw-mill.
3. Comminuted wood waste in the form of saw-dust and shavings at the saw-mill.

Besides these forms of wood waste considerable amount of it exists as "veneer waste" and bark waste that could be put to economic use.

FIBER BOARDS FROM WOOD WASTE

One of the channels in which this waste wood utilization problem has been rightly directed and one which holds the greatest potential for conversion of wood waste into useful articles of commerce, is the reconstitution of wood waste into sheets or boards. Wood is after all a cellulosic material built up of innumerable fibers of varying sizes cemented together by the finest organic binder known as lignin. If, therefore, the waste wood is split up and converted into a fibrous state by degrading and dissolving out the lignin through the action of chemicals, the high tensile strength that characterizes these wood fibers could be used again by artificial binding either with or without external binders. This then is the principle of board manufacture from wood waste in a nut shell.

Definition and Classification of Boards—The term "board" as used to-day is capable of a very wide range of interpretation based primarily on the raw material used. For our purposes, however, it would suffice to say that it is a "*synthetically reconstituted sheet of wood particles or fibers banded together with or without external binders varying in density from 0·3 to as high as 1·36 and in physical qualities*".

Fiber boards may be classified into two broad categories.

(*a*) Insulating boards or wall boards and

(*b*) Hard boards.

(*a*) *Insulating boards*—These comprise of porous rigid boards of lower density, with the wood fibres felted or pressed together in such a way as to contain a large quantity of entrapped or "dead air". Their insulating value decreases with increase in density, but the strength requirements place the lower limits of its density in the range of 14 to 20 lbs. per cubic foot (3). The thickness varies with the purpose to be used, and may be from ½″ to 4″ thickness.

(*b*) *Hard boards*—Hard board on the other hand refers to boards having a density of about 0·9 to 1·2, a high modulus of elasticity of 500,000 to 600, 000 psi and rupture 5,000 to 6,000 psi (4). The thickness of commercial hard boards generally ranges from ⅛″ to ½″.

Boards with densities intermediate between those of above two, i.e., 0·5 to 0·8 are sometimes known as semi-hard boards.

MANUFACTURING PROCESSES

General—A great many processes have been perfected for manufacturimg the so-called boards both insulating or wall boards and the hard boards – here in the United States as well as in Europe. Each process has its own advantages and has been evolved as a result of—

(*a*) the availability and the form of wood waste

(*b*) the marketability of the finished product and

(*c*) the cost of the plant, etc.

Elmendorf has classified the various processes at present in vogue into :—

1. Wet Process
2. Semi-dry or semi-wet Process
3. Dry Process.

This classification is based on the amount of the moisture present. A further subdivision of each could be possible on the basis of the process being a continuous or in batches or again whether a binder is used or not.

In the *wet process* the fibrous mat, formed by draining a fiber suspension (4–5% concentration) in water is pressed in heated platen press while still containing about 50% water. This compares closely with paper making and the masonite process, originated nearly 25 years ago constitutes the forerunner of the process.

In the *semi-dry process* wherein the waste wood usually comes from the veneer waste or from green saw-mill scrap, no water is used. Here the defibrated material is pre-pressed to form a mat before final pressing.

In the *dry-process* which utilizes waste wood from a fabricating mill using only kiln dried lumber having a moisture contant of 5% to 8%, the fibrous material is pressed directly. Where saw-dust or green wood is used, moisture content is reduced down to about 5% by use of standard drying equipment.

Preparation of Material—Whatever the process used, it is necessary that the waste wood be fragmented into smaller size. This, however, does not apply to the saw-dust and mill shaving which could directly be defiberized wherever necessary. Among the wood working industries various kinds of wood fragments are recognized, but the two major wood fragments may be classified as "chips" and "hogged wood" both of which are suitable for pulping.

"Chipping" is usually confined to the process wherein wood is severed across its fiber and split along its grain at 0·5 to 1 inch controlled intervals and the pieces so produced are more or less of uniform size.

"Hogged wood" on the other hand constitutes random fragmentation achieved by severing wood along or across the grain or at any intermediate angle to produce non-uniform chips. It is a product of the saw-mills and wood fuel industries. The board manufacturers usually prefer chips of a uniform size.

Chipping Equipment—The type of chippers available to-day may be classified according to E. W. Fobes (6) into :—

(1) Disc chippers

(2) Cylinder chippers

(3) Wood hogs

In addition, hammer mills and shredders also produce wood fragments which are directly used by the board manufacturers.

Portable chippers are available, with power supply mounted on steel wheeled trailers that can be taken right into the forests for converting the lops and tops of the trees left in the woods by the lumberman.

It is significant to note here that the modern European trend seems to be in the direction of converting the waste wood, be it in the form of cordwood, slabs or edgings, into fine thin shavings (7). It is reported that test made in Germany by Dr. Klandilz have conclusively proved the superiority of boards made out of wood shavings, which are not over 1/100 inch thick. They are produced by cutting with knives that slice off thin wafers. A more detailed reference to this will be made again at a later stage.

Screening, conveying and storage of chips—Before the chipped waste wood is sent to the attrition mills for fibre separation it is found necessary to screen the chips so as to prevent any over size chip from passing into the defiberizers. The screened over sized chips usually

above $\frac{3}{4}''$ are returned to the chipper for rechipping and the rest pass along on conveyors to the storage bins from where they could be fed to the attrition mills.

Fibre Preparation Methods—There are usually two broad methods for producing fibre for board manufacture namely by grinding and use of attrition mills (3).

(*a*) *Grinding*—Grinding can only be resorted to where the waste wood raw material is obtained in the bolt form. Grinders may be of pocket or magazine type, but in both, the wood bolt is placed parallel to the face of the grinding stone and pressed to it by a ram ground into small fibers or fiber bundles. Water is played on the surface of the grinding stone to prevent the wood from burning and to wash away the fibers already ground. Grinding has a high production for unit cost of equipment but is limited to the physical size of the stick it uses (3).

The normal size of the bolt that can be ground is about 30 inches long, 4 to 20 inches in diameter.

(*b*) *Attrition Mills*—A continuous type of fiberizing machine used both in the U.S.A. and Europe, is the Asplund Defibrator. The wood chips are pulped in the defibrator at elevated temperatures in a steam atmosphere corresponding to pressures between 125 to 175 psi. The chips are first introduced into a high temperature preheating chamber by means of automatic or plunger feeds. The temperature here ranges from 350° to 370° and causes softening of the binding substances between the individual wood fibers. The separation of the fibers is achieved by passing the chips between a rotating and a stationary disc, still under pressure. After defiberization the pulp is blown from the defiberating chamber through reciprocating or nozzle valves to a collector under atmospheric pressure. A defibrator could be expected to process 10 to 30 tons of chips per 24 hours depending on the type of the wood waste and the degree of fiberization required (3).

Another type of defiberizer which has the greatest usage in the U.S.A. is the "Bauer" pulper. This is a double-disc machine in which both the discs are rotated. Stock is fed to the centre of the discs through an opening in the centre of one and is discharged at the periphery.

Besides these two rather common types of attrition mills there are also others used for the same purpose. Among these may be mentioned the Allis Chalmers Interplane grinder, the Macmillan machine, the Elmendorf Defiberizer, the Sprout Waldron refiner and the Wienerfiner.

It would be of interest here to point out that under the Masonite process, wherein hard boards of varying densities are manufactured from wood bolts, defiberization is achieved in a battery of 20″ caliber guns. A gun is filled and closed and steam admitted until the pressure registers 1,000 psi and 550°F. After being held at this point for a few seconds the bottom valve of the gun is opened and chips exploded against a target into a brown fluffy mass of fiber which is then collected by condensed steam let off in the cyclone (8).

Cooking—In order to produce a suitable fiber for the manufacture of boards, both insulating and hard, it has often been found necessary to steam or cook the chips prior to passing them through the defiberizers. The intensity of the treatment would naturally vary with the end product in view and the degree of fibre separation desired. A mild treatment would consist of steaming at atmospheric pressure or even soaking in boiling water. A harsher treatment would naturally involve steaming at higher pressures and for longer periods.

There are some other mills that use chemicals for softening the chips. The usual chemical treatment employs either sodium hydroxide or more often neutral sodium sulphite, buffered more or less with soda ash (9).

The cooking equipment consists of either rotary or stationary digesters. The rotaries are most common and range from 12 to 18 feet in diameter. A 16-foot glove rotary holds 8 cords of chips and yields up to 85% of cooked chips at the rate of 10 cycles per day.

The degree of cooking affects the fibre yield, the depth of colour, the strength of the board, its water absorption and other properties.

At this stage it would be more advisable to take up separately the three different processes of board manufacture enumerated below :

Wet Process

The fibres as produced by the Asplund Defibrator are mixed with water and pumped through washers, refiners and screens to achieve a certain degree of uniformity and quality of fibre. The fibre reduction is, of course, predetermined by the disc setting in the defibrator and the cooking heat.

The screened fibres are then led into a four-drinier type of machine, similar to paper making machine where the board is formed into a thick continuous mat. After this the wet lap is trimmed and cut to size, the individual pieces are carried on screened racks and inserted between steam heated platens of a press at pressures up to 1,000 psi and for a time up to 30 minutes (13). The large amount of water is removed in a heating cycle long enough to dry and cure the boards. To reduce a long pressing cycle, the mat may first be prepressed to remove much of the water or sent through a tremendous drier, or dewatering screens.

The pressing of the wet mat in a continuous system is accomplished by means of a series of roll presses, some of which may be suction rolls.

The major steps in a typical wet process for manufacture of hard board are shown below :

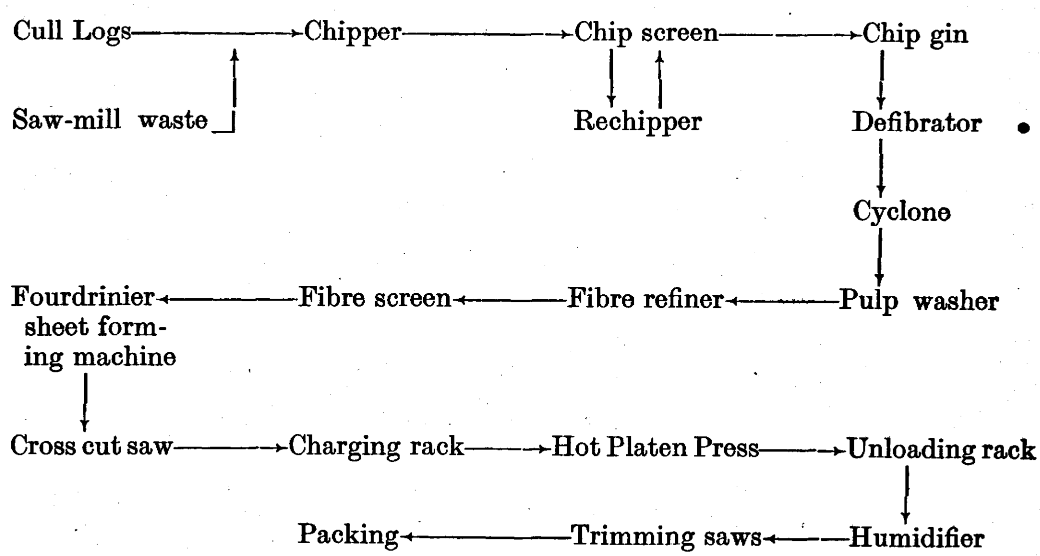


FIG. 1.—Flow Diagram of Wet Process

SEMI-DRY PROCESS

In the semi-dry process, as described by Evan (11) the wood chips are softened by cooking in a continuous steamer at pressures varying from 20 to 50 psi for a period of 8 to 20 minutes and the binder size or wax added as water emulsion to the chips prior to the defiberization. Normally 1 to 3 per cent of a thermosetting resin such as phenolic 1 to 3 per cent of a size such as Paracol (on solid weight basis) are added.

The coated chips are then directly fed into the defiberizing machines such as the Bauer Pulper or the Allis Chalmer's Interplane grinder. These attrition mills have proved very successful in dispersing the relatively small amounts of the binders and wax, etc.

The fibers on being discharged from the defiberizers are picked up in an air stream by a blower and discharged into a cyclone for air separation, with the fibers being fed directly into the felting machine. It is here that the semi-dry process essentially differs from the wet process and eliminates this expensive equipment and power necessary to handle the immense amount of water required in the wet process.

The fibers are received from the defiberizers, fall on to the floor of the felter which is a moving belt, the rate of movement being synchronized with the output of the defiberizers. As the mat emerges from the felting chamber if it has attained a height or thickness in excess of that desired for the final mat, such excess is automatically removed and returned to the infeed end of the felter. The mat emerging from the felter is 6 to 8 inches thick for $\frac{1}{4}$ inch board and is preferably compressed to maintain a thickness of about 3 inches. As the mat continues to advance on the belt past saw travelling mechanisms it is automatically cut into desired lengths for pressing.

The press used is the conventional 20 opening steam heated hard board press except that a greater daylight opening between the plates is provided for the thick mats. Stainless steel cants are permanently suspended from the bottom side of each steam plate to produce a hard, smooth face on one side of the board.

An initial high pressure of 500 to 1,000 psi is applied for a short period and thereafter the pressure is automatically decreased to a range of 125 to 200 psi for the balance of the cure. The cycle runs from 8–12 minutes for 1/4 inch board. At the end of the holding cycle, the boards are ejected from the press by the conveyor wire cloth which remained under the mat during the pressing cycle to facilitate the venting of the moisture.

As the boards received from the hot press are usually very dry, they are often placed under controlled humidity conditions and moisture content brought to 5 to 7%.

DRY PROCESS

As already stated, the manufacture of board by the "dry process" is characterized by no water being added to carry the particles or fibers of wood in suspension. Furthermore, under this process it is also customary to use even the small form of wood waste, such as saw-dust and shavings. The modern trend indicates a rapid development in the hard board manufacture by this process. Since this process utilizes saw-dust and mill shavings, both of which have rather smaller fiber length, binders are often added to achive the adhesion strength. However, this is not a "must" and techniques have been recently evolved which use no binder at all.

Basically, process consists of preparing the stock somewhat similarly to that prepared by the other two processes. The fibrous mat, formed by addition of various binders (which will be enumerated shortly) usually in small quantities depending on the binder used, is pressed in heated presses at higher pressure of 1,000–1,500 psi at higher temperatures of 300–450°F.

under a pressing cycle of $2\frac{1}{2}$ to 3 minutes. However, unlike the other two processes, the pressing is done after the mat is passed through a long drier and dried to nearly bone dryness. In a process described by Donals E. Othmer (13) where cheap chemical materials are added to the fine wood waste. This board is formed at about 500–700 psi but under a longer pressing cycle of 10 minutes.

Dry process hard board is smooth on both the sides as both of the press platens or caul plates used are smooth. Fibre prepared for dry process is usually refined to a higher degree than for wet process to allow for easier handling of the unconsolidated board. The quality of the pressed board depends on the quality of the unpressed board (3).

Because of the shorter pressing times, a press with a fewer openings is required than is used for the wet process. The board is "humidified" to a moisture content of 5·6% as in the case of the semi-dry process.

Types of Binders—As already stated the semi-dry and dry formed boards do not rely on fiber adhesion only. It is, therefore, customary to add an external binder of some sort. The type of the binder used would naturally depend on the economics of the plant, both its quality and quantity controlling the end product.

The binders may be divided into two major categories :

(1) Organic Binders and

(2) Inorganic Binders.

In the first category, the synthetic resins, both the phenolic and urea groups constitute the most important binders on both sides of the Atlantic. Germans use both phenolic and urea resins. In Great Britain boards with urea resin binder are in commercial production and now in U.S. and Canada also. The latter are finding increasing favour (11). The limiting factor in their universal utility is the cost of the raw material.

Among the other organic binders, protenic substances such as blood, vegetable and casein have been used. Their major disadvantage is their decomposition by micro-organisms. This, of course, could be remedied by addition of fungicides.

Considerable interest is visible at present in the use of lignin as an organic binder. Lignin is itself a constituent of wood. Two types of lignin, soda lignin and lignosulphonic acids are well known. Soda lignins have good flow properties but with wood waste alone produce weak bonds. Indications are that it will be more frequently used in future in combination with synthetic resins to produce better bonds.

In the second category of inorganic binders, fall the various Magnesium salts, silicates and portland cement. Bender (11) reports that boards out of pine shavings soaked in magnesium sulphate solution and dusted with magnesium oxide have been successfully made in Europe. However, these compounds are less abundant and more expensive and cannot, therefore, be economically employed.

Portland cement has also been used in a number of boards as a binder but such a board has been found to be unsuited for external use as the rigidity of the set cement on one hand, and the shrinking and swelling of partly unbeded wood particles on the other hand somewhat conflict.

Considerable amount of experimental work has been done on the various binders in order to evolve boards of acceptable quality with desirable physical qualitites. The process and the size or range of the particle used have naturally a considerable play in this sort of work.

Board Requirements—This constitutes an important phase of board manufacture from waste wood as the marketability of the end products depends entirely on its desirable characteristics for the purpose it is being put to. There are innumerable uses to which the boards prepared by any of the processes ennumerated earlier have been put, and each use has its own set of specific requirements. If a board made of wood waste is to hold its own in the competitive field, it must always have as desirable qualities as wood or plywood or any other material available in the market for the same purpose. Furthermore, it must be available at competitive rates. It would, therefore, be difficult to draft a uniform set of requirements that a board ought to fulfill. However, there are certain basic requirements that all the boards are expected to fullfil, although their relative importance may be rather debatable.

Remembering that all the requirements are to be met to a satisfactory degree for the purpose in view they may be enumerated as below:

1. *Dimensional Stability*—It is desirable that there should be a minimum change in the flatness and dimension of the board with changes in atmospheric humidity. This requirement also includes a certain amount of resistance to moisture generally.

2. *Texture and Pleasing Appearance*—This is important from the point of view of salability. Surface texture should be smooth and solid and free of excessive pits.

3. *Strength*—The binding strength or the modulus of rupture should at least be greater than that of even the strongest woods across the grain. Some boards would have to satisfy considerably rigorous requirements in this direction.

4. *Workability*—It must not be unduly difficult to saw, drill, plane, sand or even to glue the board depending on its use.

5. *Screw holding power*—It is often not realized how important a part this characteristic of the board plays in its daily life. In order to be utilized in those spheres where plywood or wood is ruled out on account of some reason, a board should have adequate screw or nail holding power.

6. *Ease of handling*—This means that it should be reasonably light in weight, of convenient size and not easily damaged in handling. It must have rigidity but not so that it will chip off in handling.

It should be realized that these requirements are more in order as far as the so-called "hard boards" are concerned. Insulating boards must fulfil additional requirements in its own field.

ECONOMIC CONSIDERATIONS

One of the biggest problems in waste wood utilization is that of collecting the material. It is not enough to know how much or what quantity of waste wood of all kinds is either burned or allowed to rot, but "what is the quantity that can fall in the economic range of working". Waste wood residue has a low value and, therefore, cannot bear heavy transport charges. In general, an individual plant, planning waste woods must not attempt to draw on wood sources over 15 miles distance from the plant (2). Of course this is not to be taken as a rigorous condition as the final value of the end product would depend on a great number of other factors and also on the process evolved and the equipment required.

The factors that require consideration may be enumerated as below:

(1) Availability of raw material, both waste wood and the binder used. This includes sustained quantities.

(2) Form of waste wood, as this would dictate the type of equipment required and the process of manufacture.

(3) Cost of raw material.

(4) Facility of marketing the manufactured product.

(5) Facility for manufacture at low cost – size of plant, power, labour, etc.

It is, therefore, apparent that a great many factors which cause the economics of wood waste utilization are to be considered.

Capital investment on plant equipment is a very important item of consideration. This would depend on two major considerations :

(*a*) The total daily production aimed at and,

(*b*) The process of manufacture.

It would be difficult to deal here with the detailed statistics of cost, but it may be of help to give you some idea on the subject of capital investment and its manufacturing costs.

An estimate of investment required by a plant producing 160,000 square feet of 1/8 inch board by a continuous wet process has been given as $ 1,900,000 (2). This, of course, is a very high figure. The plant uses slabs of edgings estimated at $ 7 ·00 per ton and the manufacturing cost has been listed as $ 21 ·70 per 1,000 sq. feet of board.

In a wet batch process, a plant with a daily output of 50,000 square feet of ¼ inch board (32 tons) requires an investment of $ 800,000. Slabs and edgings at $ 7 ·00 per ton are used and manufacturing costs come to $ 36 ·80 per 1,000 sq. feet of board (2).

Bender (11) has estimated a plant investment as low as $ 111,000 for a dry formed resin bonded board using saw-dust. Elmendorf (5) on the other hand estimates an investment of $ 350,000 for a similar board produced at the rate of 50,000 square feet daily (32 tons) of ¼ inch thickness. Manufacturing cost using 8% phenolic resin and saw-dust at $ 4 ·00 per ton has been given as $ 44 ·00 per 1,000 sq. feet.

These figures may vary considerably from plant to plant but give an idea of the range in plant investment and manufacturing cost. The Plaswood Corporation of Detroit, Michigan uses softwood planer shavings mixed with 25% saw-dust and resin as binder to produce a wall board (2). Hardwoods may be mixed with softwoods. To produce 25,000 to 30,000 sq. feet of ¼ inch board daily (16–20 tons) the cost of equipment has been estimated as low as $ 81,400.

From the point of view of cost, it appears that the equipment for the boards formed by "Dry Process" appear to be the lowest. Besides the wood waste that is commonly used in this process being saw-dust and mill shavings there seem to be indications that future will see more of boards being manufactured by this process. Saw-dust is indeed an ideal starting material for structural boards. In many locations it has a very low market value and is produced in sufficient quantities to assure a steady supply of raw material. Therefore, one of the biggest problems in waste utilization, that of collecting the material, is not present in this case. Experiments have proved that saw-dust boards are sufficiently strong for a number of purposes such as partitions, ceiling and core boards. The only drawback seems to be the high prices of resins, but with developing techniques the percentage of resin is so much reduced – 3 to 6% is now being commonly used – that one can look forward to great development in this direction.

In this respect it is interesting to note that a recent development on the Pacific coast makes use of decayed wood – brown rot – claimed to be largely lignin, as a binder for hard

board (14). It is obvious that the derivation of a binder from wood waste itself would eliminate the greatest obstacle to a substantial production of dry formed boards.

MODERN TRENDS IN EUROPE AND AMERICA

Manufacture of "Wood Waste Board" in Germany—Somewhere in the beginning of this paper, I mentioned the fact that the present trend in Europe seems to be in the direction of using "Wood shavings" for the manufacture of boards out of wood waste. In an interesting article recently submitted by Elmendorf (7) to the American Society of Mechanical Engineers he points out that there are at least a dozen plants in Germany and a few others in France and other neighbouring countries making boards known as "shaving board" or "waste wood core board" about 3/4 inch thick in large sizes for use as table tops and other furniture parts after veneering. It is claimed that such a core made out of wood waste is far superior to lumber core used in the U.S.A. for veneer manufacture. Further the wood waste core board is being used in Europe without any cross bonding. The cost estimates further show that the wood waste core board can be manufactured at half the cost of the lumber core and veneer cross bonding.

The "wood waste core board" is being produced in Germany out of several types of wood waste available in the vicinity of the plant. They may be in the form of small or cull logs, saw-mill slabs or edgings, veneer waste and even dry saw-dust and mill shavings. The type of the wood waste of course determines the type of board manufactured.

In its manufacture, small logs or other solid wood is cut into "shavings" by special machines built for that purpose. These shavings are dried so that no undue amount of steam is subsequently engendered in the hot plate press. The drying may be done in any of the conventional driers. The dry shavings are then coated with liquid urea resin about 8% by dry weight, by introducing it as a fine spray while the shavings are agitated or with special coating machines. The shavings are then transferred to the forming frames or moulds, levelled off manually, and transported with the frames to the pre-press for compacting. From there after the removal of the frame the caul with its fiber mat goes to the hot press. Stops in the press determine the thickness and therefore the density of the board.

Usually a pressing cycle of 30 minutes or so is adopted and a board with 0·55 to 0·65 density obtained. The thickness may range from 1/2 inch to about 7/8 inch, the predominating thickness being 3/4 inch and the panel may be 4 × 8 feet in size or larger.

In contrast to this the present trend in the U.S.A. appears to be toward utilization of more comminuted wood such as saw-dust into "fine wood particle" board.

Different "dry" processes for manufacture of fine wood particle boards have been and are being evolved. A typical dry process has already been described. High density "wood particle board" according to the described process is in production in two plants on the Mississippi River for use in place of plywood in the manufacture of kitchen cabinets.

A powdered phenolic resin is used in place of the liquid urea of the European shaving boards. In a "dry" process further developed by Elmendorf Research, Inc., and tested in a pilot plant production to make a thick board having a density and strength comparable with the "shaving board". A shorter pressing cycle of 12 minutes against 30 minutes required for the shaving boards has been found necessary. This is an important development because it means that the man hours of labour per ton of production are cut down to about one half, as is the capital investment and amortization of the investment.

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AN EMPIRICAL FORMULA FOR DETERMINATION OF LOSS OF FIREWOOD BY DRIAGE

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In an earlier communication[1], loss of ordinary country firewood of different varieties by driage during varying periods of storage have been discussed. As pointed out therein these losses depend on various factors, viz., variety, season, period of drying, dimension and nature of the billets, nature of stacking, the initial moisture content, etc., but in actual practice, it is neither necessary nor possible to know and control all these factors. But at the same time, various trades, industries and administrative departments, official and non-official, often require to know, approximately at least, nature of these losses by driage by a rough and ready means.

It is, therefore, proposed in this paper to indicate an empirical equation for estimating driage of firewood with time.

The general relationship obtained from an analysis of the data for the driage of Mango (*Mangifera indica*), *Simul* (*Bombax malabaricum*) and Banian (*Ficus bengalensis*) firewood as experimented at Subirnagar in Rangpur District and mentioned in the communication under reference and also from the data given by Rehman[2], may be expressed as

$$Q = a + b \times c^t \qquad \text{.......... (1).}$$

Where Q is the percentage of the total quantity of firewood at any time t, t is the time in weeks and a, b and c are constants.

C is always less than unity so that the term $b \times c^t$ decreases with increase in time with the result that Q decreases as t increases

At $t = 0$, i.e., at the beginning of the experiment where there has been no driage

$$Q_0 = a + b = 100 \qquad \text{.......... (2).}$$

When t is sufficiently large c^t approaches zero (because c is less than unity) and this happens when no further driage occurs with further lapse of time, the firewood already having attained the air-dry condition.

For this value of $t = \tau$ say

$$Q_\tau = a \qquad \text{.......... (3).}$$

From (2) we get $b = 100 - a$.

With the help of these boundary conditions and also by applying the method indicated by Mills for the determination of constant of Gompertz and Logistic equations, the values of the constants in case of Mango (*Mangifera indica*) firewood were found out and the resultant equation obtained is

$$Q = 59 \cdot 36 + 40 \cdot 64 \times (\cdot 85665)^t$$

In case of Mango (*Mangifera indica*) firewood detailed week by week data were available and the method for determining the values of the constants in Gompertz or Logistic curve could be employed. But in other cases, specially in the 3 varieties of firewood dealt with

by Rehman, the data were less detailed and hence a and b were found from the boundary conditions and c was found from each observed value of Q with the help of the known values of a and b. Average of these values of c were taken for c of the equation.

The observed and estimated values of Q with time for Mango (*Mangifera indica*) firewood from the equation are given in Table I below :—

TABLE I

Driage of Mango (*Mangifera indica*) firewood

$$Q = 59{\cdot}36 + 40{\cdot}64\ ({\cdot}85665)^t$$

(During November–April ; in the open air)

Time in weeks	Quantity of firewood	
	Observed	Estimated
0	100	100
1	92	94·1
4	82	81·2
9	70	69·4
13	66	64·8
17	64	62·3
21	60	60·9

Similar equation of relationship with different values of constants were found to hold good in case of *Simul* (*Bombax malabaricum*) and Banian (*Ficus bengalensis*) firewood experimented at Subirnagar in Rangpur District and the results are given in Tables II and III below :—

TABLE II

Driage of *Simul* (*Bombax malabaricum*) firewood

$$Q = 50 + 50 \times ({\cdot}87494)^t$$

(November–April ; under shade)

Time in weeks	Quantity of firewood	
	Observed	Estimated
0	100	100
2	86	88·1
4	80	79·4
9	70	65·1
11	64	61·6
13	60	58·9
16	56	55·0
19	52	54·0
20	50	53·5

TABLE III

Banian (*Ficus bengalensis*) firewood

$$Q = 68 + 32 (\cdot 94968)^t$$

(June–December ; open air, i.e., during rains and after)

Time in weeks	Quantity of firewood	
	Observed	Estimated
0	100	100
5	96	92·7
9	88	88·1
13½	84	83·9
18	76	80·6
22	68	78·3
29	68	75·1

The data of drying of firewood published by Rehman[2] were also found to come under this general empirical equation and the results are shown below in Tables IV, V and VI. These experiments were performed by Rehman in Dehra Dun.

TABLE IV

Sal (*Shorea robusta*) firewood

$$Q = 60 \cdot 3 + 39 \cdot 7 \times (\cdot 92014)^t$$

(December–June ; under shade)

Time in weeks	Quantity of firewood	
	Observed	Estimated
0	100	100
5	87·3	86·4
11	76·8	70·7
18	67·1	69·1
28	60·3	64·1

TABLE V

Jaman (*Eugenia jambolana*) firewood

$$Q = 54 \cdot 2 + 45 \cdot 8 \times (\cdot 92653)^t$$

(November–June ; under shade)

Time in weeks	Quantity of firewood	
	Observed	Estimated
0	100	100
4½	84·8	85·4
9½	76	75·3
14	72	68·9
18	67·8	64·8
23	62	61·2
30½	55·1	57·6
33	54·2	56·9

TABLE VI

Kaula (*Machilus duthiei*) firewood

$$Q = 51\cdot7 + 48\cdot3 \times (\cdot92719)^t$$

(November–June ; under shade)

Time in weeks	Quantity of firewood	
	Observed	Estimated
0	100	100
$4\frac{1}{2}$	76	75·2
14	72·1	68·5
18	68	64·1
23	62·1	60·1
$30\frac{1}{2}$	53·8	56·5
33	51·7	55·6

The values of the constants of the general equation for different varieties of firewood and other features are summarized in Table VII below :—

TABLE VII

Variety of firewood	Conditions of driage, etc.	Values of constants			Value of t corresponding to perfect air-dry condition of wood
		a	b	c	
Mango (*Mangifera indica*)	Nov.–April open air stacking, split billets of 3′ length of 6″ diameter in Rangpur ..	59·36	40·64	·85665	21
Simul (*Bombax malabaricum*)	Do. under shade ..	50	50	·87494	20
Banian (*Ficus bengalensis*)	Do. in June–December open air	68	32	·94968	22
Sal (*Shorea robusta*)	December–June under shade in Dehra Dun other condition Do.	60·3	39·7	·92014	28
Jaman (*Eugenia jambolana*)	Do. ..	54·2	45·8	·92653	33
Kaula (*Machilus duthiei*)	Do. ..	51·7	48·3	·92719	33

Apparently, a, is the quantity of firewood (in percentage) that will be ultimately available after driage and b, the quantity that is liable to be lost due to driage. From the above results it appears that we will not be far out of actual facts if in any case of unknown country firewood, which are usually not very mature or are fairly soft or in case of a mixed variety of firewood we adopt as a rough and ready formula—

$$Q = 55 + 45 \times \cdot 9^t$$

to determine the quantity, in per cent, that will be available after driage in course of a time t. In case of mature or substantial firewood, e.g., in case of Banian (*Ficus bengalensis*) a nearer approach would be provided by

$$Q = 65 + 35 \times \cdot 95^t$$

It has been observed both in Subirnagar experiments and also at Dehra Dun by Rehman that ultimately there is little difference between driage in the open and under shade.

From the relation thus found it will be easy to anticipate, estimate or explain the amount of loss that is likely to take place in a given quantity of firewood by driage approximately. And such an estimate is often required by trade, industry or management who have to deal with firewood in large quantities.

Also, from the relation

$$Q = a + bc^t$$

$$\frac{dQ}{dt} = bc^t \times \log_e c$$

Therefore, by examining the driage of a lot of firewood for a week or two, i.e., from an observation of $\frac{dq}{dt}$ we can find the value of t from a knowledge of the constants b and c. Thus, we may say the approximate period of driage of a given unknown sample of firewood, i.e., how much it has already lost and how much more it is expected to lose by drying and this is an important factor in negotiating purchase or for similar other purposes.

In Burma Refugee Organization Camp which required 25,000 mds. of firewood per month at one time these informations were most urgently needed and were very much useful.

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NON-CEREAL FOODS: TUBERS OF *DIOSCOREA* SPECIES

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It has already been reported that the tubers of *Dioscorea hispida* Dennst, when processed, yield an important non-cereal starchy food material[1]. Continuing the search for fresh sources of food from non-cereal materials, the tubers of *D. bulbifera* Linn., *D. alata* Linn., *D. sativa* Linn. and *D. anguina* Roxb. have been examined. They all occur wild in nature; but some of them, *D. alata* and *D. sativa*, and to an extent *D. bulbifera* are also extensively cultivated for the sake of their edible tubers. The wild varieties usually contain certain poisonous alkaloids, bitter in taste, and are not edible in their natural state. Even those species, which do not contain any appreciable amounts of the alkaloids, cannot be eaten, since they, containing calcium oxalate and some volatile acrid principles, produce an irritant action on the tongue and the throat.

D. bulbifera—The plant is a climber which is found throughout the moist tropics of the old world[2]. In India it occurs wild and in abundance in the forest regions of Assam and the Western Ghats up to Bombay. To a lesser extent it is found in Kashmir, Punjab, Himachal Pradesh and Uttar Pradesh in the Himalayan and the Siwalik forests[3]. Certain varieties of the plant are also cultivated in the Bombay State, particularly Konkan. Some of the common names of the tubers of the plant are *Brahmikanda*, *Varahikanda* and *Vyadhihanta* in Sanskrit, and *Karukand* and *Zaminkand* in Hindi. They are called *Karinda*, *Karanda* or *Karukarinda* in Bombay, *Kurukanda* in Madhya Pradesh, *Kathalu*, *Patni-alu* or *Mati-alu* in Assam and *Adividumpa*, *Kayapendalam* or *Chedupeddadumpa* in Andhra.

The tubers, each weighing several pounds normally, contain about 78 per cent of starch; yet in their natural state, like the tubers of *D. hispida*, they are not edible, since they also contain some poisonous alkaloids (0·0175%).

D. alata is a creeper with longish pointed leaves. It occurs wild in certain parts of India, particularly Konkan. It is much cultivated in various parts of the country, especially on the Coramandal coast and in the Carnatic[3]. Its tubers are oblong and often attain a great size, each weighing 80 to 100 lbs[2]. They are called *Dandalu* in Sanskrit and *Kham-alu* or *Chupri-alu* in Hindi and Bengali. They are also called *Kamalu* in Bombay, *Ratalu* in Gujerat and *Gudimidonda pendalam* or *Niluvu pendalam* in Andhra. The cultivated varieties are extensively eaten. Even the wild varieties do not contain any alkaloids; but they contain calcium oxalate and the acrid principles.

D. sativa, a climber with quite glabrous terete stem, occurs wild and cultivated in different parts of India and the Archipelago. It is one of the most common species cultivated[3]. Its tubers, which are quite large and variable in form, are known as *Ratalu* in Hindi; sometimes they are called *Karukand*. Like the tubers of *D. alata*, these too do not contain any alkaloids.

D. anguina is a small climber developing from woody root stock, and is a native of the Calcutta region[3]. It bears potato-like axillary bulbils or tubers which are 1″ to 2″ across with a greyish or greyish-brown skin, without conspicuous eyes but with rootlets. They are known as *Kukuralu* in Bengal, *Kulkuri* or *Kukuri-sanga* in Bihar and *Kosa-alu* in Orissa. These too do not contain alkaloids; however, the wild tubers are not fit to be eaten because of the presence of calcium oxalate and acrid principles.

A chemical examination of the tubers of the different species of *Dioscorea* mentioned above has shown that they contain above 60 per cent of starch ; however, the wild varieties are not suitable in their natural state for human consumption, because some of them contain poisonous alkaloids (dioscorine) and all of them calcium oxalate and certain acrid principles which produce an irritant action on the tongue and the throat. These require a preliminary treatment before they are rendered edible and free from the poisonous alkaloids. The common treatment prevalent amongst the local inhabitants is to grate the tubers, mix with lime or ashes obtained by burning certain leaves, make it into a dough and roast in plantain-leaf wrappers. An alternative method is to steep the tubers in water containing the ashes or to boil them in *khar* (alkali) or acidulated water[3]. These methods are laborious and time-consuming ; further they may not be quite effective. It has now been found that the method developed in these laboratories in connection with the tubers of *D. hispida*, namely, oxidation with lime water and potassium permanganate, is quite effective in destroying the poisonous principles and rendering the different *Dioscorea* tubers quite edible.

The tubers used in the present investigation were obtained from the forest areas indicated :—*D. bulbifera* from Chanda Forest Division (Madhya Pradesh) ; *D. alata* from Chedleth Range (Malabar) ; *D. sativa* from Bilaspur Division (Madhya Pradesh) and *D. anguina* from Rydok Range (West Bengal). These were washed well with water and peeled mechanically with a knife. The debarked roots were cut into halves lengthwise and then into small bits, dried in the sun and powdered to 80 mesh fineness, as in the case of *D. hispida* tubers. The powders thus obtained ("unprocessed flours") were brownish-yellow in colour, and contained different percentages of moisture (Table I). They were analysed according to standard methods[4, 5] and the following results (zero-moisture basis ; Table II) were obtained. For the sake of comparison the values of Hooper, wherever they were reported, are also given.

TABLE I

	Colour Lovibond tintometer		Moisture
	Yellow	Red	
D. bulbifera	1·2	1·3	11·60 per cent
D. alata	2·1	2·4	11·40 Do.
D. sativa	1·9	1·7	8·68 Do.
D. anguina	1·8	2·0	12·00 Do.

TABLE II

	D. bulbifera			*D. alata*			*D. sativa*		*D. anguina*		
	Unprocessed flour			Unprocessed flour					Unprocessed flour		
	Hooper's values	Values of the authors	Processed flour	Hooper's values	Values of the authors	Processed flour	Unprocessed flour	Processed flour	Hooper's values	Values of the authors	Processed flour
	%	%	%	%	%	%	%	%	%	%	%
Fat	0·75–1·28	0·81	0·56	0·59–0·74	0·85	0·38	1·10	0·43	0·56–1·13	0·73	0·35
Albuminoids ..	7·35–13·31	6·56	6·28	7·96–11·01	5·83	5·11	5·37	4·98	11·44–12·45	8·50	7·13
Fibre	3·28–9·64	10·23	8·51	2·19–6·12	12·80	9·79	19·47	13·31	2·94–3·36	21·47	14·97
Colouring matter (alcohol extracted)..	..	0·60	..	..	1·07	0·78	1·03	0·71	..	0·92	0·78
Non-fibre carbohydrates	75·11–81·39	78·01	83·31	77·01–85·02	76·30	82·74	68·46	78·93	78·42–81·34	63·10	74·25
Inorganic matter (by difference) ..	..	3·79	1·34	..	3·15	1·20	4·57	1·64	..	5·28	2·52
Ash	3·31–7·08	4·16	1·57	4·23–5·24	2·97	1·03	4·44	1·51	3·72–4·54	5·04	2·61

The ashes contained mostly $\overset{+}{Na}$, $\overset{+}{K}$, $\overset{++}{Ca}$, $\overset{++}{Mg}$, and $\overset{+++}{Fe}$ as the metallic radicles and $\overset{''}{CO_3}$, $\overset{''}{SO_4}$ and $\overset{'''}{PO_4}$ as the acid radicles along with some silica.

D. bulbifera powder contained 0·0175 per cent of the poisonous alkaloid, while the other powders were devoid of it. As in the case of *D. hispida*, the poisonous or the bitter principles were either eliminated or destroyed by suspending the powder in 4 to 5 times its weight of saturated lime water containing 0·005 per cent of potassium permanganate and thoroughly agitating for an hour. The excess of permanganate and the liberated manganese dioxide were removed by acidifying the mixture with hydrochloric acid and subsequently treating it with the requisite amount of sodium bisulphite. After standing for 3 to 4 hours, the purified flour was filtered, washed with water and dried in air at the ordinary temperature. The materials which were brownish in colour did not give any test for alkaloids. Their analytical data are reported in Table II under "processed flour".

The flours were partly soluble in cold water and more so in hot water, and the aqueous solutions gave with iodine a deep blue colour, characteristic of starch. On hydrolysis with dilute sulphuric acid, they produced only glucose and no other sugar or uronic acid (the horizontal migration method of paper chromatography[7]). The main constituent of the flours is, therefore, starch. Its properties will be described elsewhere.

It is, therefore, clear that the "processed" flours of the *Dioscorea* tubers consist mostly of starch. Hence they can form the starting material for the glucose and the starch industries. In addition to starch, they contain proteins, fibre and inorganic salts in varying proportions. They may, therefore, be useful as food in admixture with wheat flour, or for the production of "synthetic rice"[8].

On a large scale the processed flour and the starch therefrom can be manufactured as in the case of *D. hispida*, the details of which have already been published in a previous issue of this journal. If there is any need to do so for want of abundance of any particular species in any locality, the tubers of all the occurring species may be collected and worked up together.

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FOREST FIRES

BY M. HAKIMUDDIN

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Forest fires in Pilibhit, U.P. and in P.E.P.S.U. Government forests published in the *Pioneer* dated 17th April and 11th June 1953 respectively as having done lacs of damage are not surprising. They are usual every summer, inspite of equally lacs of rupees spent every year on our present fire conservancy.

Protection of forests against accidental fires by means of fire lines, fire watches and telephones, costing lacs of rupees yearly as introduced by the British, is not the correct remedy. The results of which are simply disappointing, that we are unable to protect any forest area for more than a few years only, except the evergreen damp forests.

Observations during my 35 years of forest service and extensive tours in U.P. forests as Instructor of the U.P. Forest Training School and at the Forest College, Dehra Dun and as Divisional Forest Officer, I have hardly seen a forest block or a Range saved from accidental fires for more than a year, two or at the most five, while longer is the gap between the two fires on the same area, heavier is the damage to the forest crops. This defeats the objects of our present fire conservancy. They destroy most of the young crops and substantial percentage of the middle-aged trees also and damage the vitality of all the surviving trees, which become hollow and defective in many ways for timber.

The remedy lies only in following the natural course with little modification. There are two extreme conditions in the forests every year, viz., it is so damp and green during the rains that it will not burn even with the help of Kerosine oil, while it becomes highly combustible during the summer. These two extreme conditions change gradually. The villagers and graziers as a necessity try to burn these forests from the middle of winter annually to get new grass as fodder for their cattle, which is their economic wealth, and this habit, desire and need of the people to burn the forests for fodder cannot be stopped effectively by fire lines, fire watches and telephones, hence there is constant failure. To add to this is the enmity of the villagers, graziers and contractor's men caused by the misdeeds of the lower forest staff during the season, which is revenged in summer by burning the forests.

If instead of our persisting in the most expensive, harmful and ineffective present method of fire conservancy, we try to minimize the bad affects of the accidental fires in summer, the results will be far better in every respect by :—

(1) abolishing all fire lines and fire watchers and save lacs of rupees spent yearly on their maintenance and utilizing large areas of fire lines for growing timber,

(2) burn our forests ourselves, patch by patch earlier than the villagers and graziers burn, as it starts drying up here and there, say from December and finishing by about mid February each year. Then alone our forests will really be saved from severe damages yearly from accidental fires during summer as there will not be much left to burn except the newly fallen leaves and if they catch fire again it will almost be harmless.

(3) this proposed departmental early burning will remove the thick layer of combustible material during winter, expose the ground for the reception of seeds and the complicated problem of sal natural regeneration will also be solved. Examples of fine sal regeneration on fire lines which are burnt yearly are only

too numerous in every forest division, with surprising absence of regeneration on either side of these fire lines in the same forests.

(4) It will reduce thick undergrowth of weeds and climbers which hinders the free growth of valuable young crops and will eventually reduce our expenses on subsequent cultural operations.

(5) The departmental yearly burnings will also reduce various insects, white ants, borers, fungi, etc., which are injurious to the forest crop, without any special arrangements or expenses, except a few match boxes supplied to the Forest Guards to start burning their forests from early in winter whenever and wherever it will burn in big or small patches.

(6) It will encourage filling up large grassy blanks with stunted sal regeneration as found in large numbers in Kheri and Pilibhit Forest Divisions and which are called *phantas* and *chaurs.*

(7) Lastly there will be savings of lacs of rupees annually both by abolishing the present fire conservancy and preventing the destruction of our forest wealth by accidental summer fires every year.

(8) If what I have said above is not believable and the present system of fire conservancy is really necessary, there would have been no forests handed down to the British from the previous rulers of this country, who had no fire conservancy. Nature is not dependent on human aid. Early burnings by villagers and graziers every year are in fact beneficial for the well being and continuity of the forests. It helps regeneration and keeps down the natural enemies of the forests, while summer fires are destructive. I am sure it will produce still better results if the departmental burnings are a bit earlier patch by patch and not to burn big forest areas in one sweep when every thing is dry, which will certainly be harmful.

(9) We see in Nepal forests bordering our *tarai* sal forests, that without any fire conservancy, there is ample regeneration everywhere, conspicuous absence of thick litter and of thick undergrowth of harmful weeds and climbers except in damp area. The Nepal forest produces far superior sal logs and other timbers than ours and there is no fire conservancy.

(10) If it is feared for any reason to affect a wholesale change in their wasteful present system of fire conservancy, there will be no harm in trying the proposed experiment in their worst fire affected areas like Pilibhit and South Kheri Forest Divisions of the U.P. where the damage by accidental fires annually are very heavy and are seen every summer by passengers from the trains passing through the above Divisions.

(11) The sights of the annual destructions of the valuable sal, *chir* and deodar forests here and there all over U.P. by accidental summer fires are shocking. I have been advocating the substitution of the present fire conservancy by early departmental burnings since 1927 in purely national interest, but unfortunately I always met with opposition from higher quarters and my articles on the subject were also not published. May I request the Honourable Editor now in a free country to let the forest officers know my observations and let them criticize it or agree to my proposal in national interest, for which I shall be grateful.

VOLUME 79 NUMBER 11

INDIAN FORESTER

NOVEMBER, 1953

INDIA'S EXISTENCE DEPENDS ON THE PRESERVATION OF HER FORESTS

BY M. D. CHATURVEDI, I.F.S.

Inspector-General of Forests

Few people realize that forestry is the foster-mother of agriculture. The rôle of forests in conditioning the weather, in conserving moisture, in preventing the erosion of soil, and in short, in maintaining the physical conditions which make agriculture possible, is not yet fully appreciated. It does not seem to be sufficiently recognized that proud and powerful empires like those of Egypt and Babylon disappeared, not under the heel of a foreign foe, but by the destruction they wrought upon themselves by reckless exploitation of their tree-lands, which spelt, in effect, the squandering of their resources in soil and water. They literally cut the branch which supported them. The disappearance of forests led to the drying up of the perennial springs and loss of soil which supported life.

Nearer home, the Rajputana desert, frequent duststorms and devastating floods cast a lurid shadow of the shape of things to come. The thoughtless extension of cultivation in treelands in quest of more food, does not augur well for the future. The solution of the food problem lies in intensive cultivation, and not in its extension into the pockets of tree growth still left in a sea of cultivation.

The improvidence of the tiller of the soil recoils upon himself, in the shape of diminishing returns from his fields. With the disappearance of the physical defences which the cultivator has in forests, he finds himself helpless against the destructive forces of Nature, which he himself has unleashed. This is not all. His only source of fuel supply gone with the destruction of woods, he is compelled to burn his cowdung which should go to enrich his impoverished fields. As food is still not available without fuel to cook it, the peasant has no option but to divert his valuable farm-yard manure to his hearth and deprive himself of the increased yield which it would have fetched had he utilized it in his field. Strange as it may sound, the fact remains that the average cultivator in India cooks his wheat with wheat and rice with rice, which after all his manure potentially represents. Viewed against this background, the import both of manure and food leaves one breathless. The Grow-More-Food slogan needs to be re-written as Grow-More-Fuel.

The dependence of agriculture on forests was accorded recognition in the nineties of the last century, by Dr. Voelcker, who in his report on the "Improvement of Indian Agriculture" stressed the need for formulating a forest policy with a bias in favour of agricultural interests. His recommendations found reflection in the Forest Policy enunciated by the then Government of India, in 1894. The salient features of this policy hold as good to-day as they did about sixty years ago. The surprise is not that this policy suffered from certain defects, but that we had a policy at all at the turn of the century. Even to-day, there are few countries in the world which have a declared forest policy.

The criticism generally directed against the old policy centres round its provision for the relinquishment of forest land "without hesitation" for the extension of agriculture. At the time, when the extent of our forests was believed to be unlimited and forest resources considered to be inexhaustible, forests naturally came to be treated as a reserve to be drawn upon for the extension of cultivation. The land revenue derived from agricultural lands constituted the mainstay of the Government of the day. As a matter of fact, large forest tracts were signed away to enterprising speculators in consideration of a nominal royalty for bringing them under the plough. Some of our valuable forests to-day are not those reserved as such, but those taken over by Government due to the failure of their lessees to bring them under cultivation.

During the interval that has elapsed since the enunciation of the 1894 policy, far-reaching changes have taken place in the physical, economic and political fields. The protective rôle of forests has come to be better understood. The part they play in the holding up of hill-sides, in the control of floods, in the reduction of run-off, in the maintenance of perennial streams, in the prevention of soil erosion, is no longer a matter for speculation. Forests act as a cushion against the forces of Nature, as a damper against heat and cold, and as a buffer against wind and water. The importance of forests is even greater in a land where the periodicity in the precipitation of rain, confined as it is to the four monsoon months, adds to its severity. The challenge of millions and millions of drops of rain can only be met by millions and millions of tiny tremulous leaves.

In the economic field, agriculture and industry have come to lean more and more heavily upon forest produce. In the days gone by, the only major demand for timber was that for track sleepers and for constructional purposes. With the development of a variety of industries, forests are now called upon to provide *semal* for matches, mulberry for sports-ware, *haldu* for bobbins, bamboo for cellulose and paper, and softwoods for the plywood industry. This is not all. There is an ever-increasing demand for tans and gums, resins and drugs, rosin and turpentine, to mention a few items at random.

The post-war reconstruction schemes such as the river valley projects, the development of electricity, the extension of communications, and the establishment of cottage industries have given rise to an unprecedented demand for the produce of the forests. Then again, the two world wars which India has gone through during the first half of the century have disclosed an unsuspected dependence of national defence on forests.

Although forestry recognizes no political boundaries, the revolutionary changes in the political scene have not been without serious repercussions on the forest policy of 1894. India has become a sovereign democratic republic, a union of autonomous States. Each component State enjoys now complete independence in the administration of its forests. Inter-State problems alone remain the responsibility of the Centre.

A new orientation in the forest policy of the country was, therefore, urgently called for. The national forest policy of India, re-enunciated in 1952, takes into account not only the factors enumerated above, but also the fact that the population of India, both of human beings and cattle, has increased by leaps and bounds resulting in relentless pressure on land.

Among the landmarks of the new policy, the first and foremost is the recognition accorded to the intrinsic right of forests to a permanent and adequate share of land. Detailed surveys carried out revealed both the inadequacy and maldistribution of the existing forests to meet the needs of a growing population. No longer are forests to be tolerated on sufferance until better use can be found for the land they occupy. Forestry is now considered to be a recognized form of land-use of vital importance in the national economy.

An indication has been provided of the proportion of land which should be permanently maintained under forests. This naturally varies with the configuration of the ground and rainfall. Thus, while in the flat Indo-Gangetic plain where slope is imperceptible and erosion is not a serious problem, the average proportion of forest land to be aimed at need not be more than 20% of the total land area ; in the mountainous tracts, with higher rainfall, a much greater area (about 60%) must be maintained under forest growth. It stands to reason that States better suited for the growth of trees must continue to maintain a higher proportion of their land under forests to make good the deficiency in inhospitable tracts not conducive to tree growth.

Measures to be adopted in stepping up the proportion of forest land include dedication of State lands along canal banks, railway and road lands, and the allocation of erstwhile military camping grounds for the creation of fuel and fodder reserves.

Attention is focussed on securing scientific management in private forests which were sacrificed in the past for individual gain. The limited span of human life renders it difficult for an individual to take a long-range view and be content with the management of forests on the basis of a rotation in the region of a 100 years or more. The State alone can think in terms of the present generation as well as the generations to come. State control of the management of private forests has been justified on physical, climatic and economic grounds, and follow the general pattern of legislation enacted in various States. Only in the case of recalcitrant owners who are tempted to sacrifice their capital for immediate gain is interference from the State called for.

To instil among the masses a love for trees – the silent sentinels mounting guard on mother earth – a national festival for trees *Vana Mahotsava* has been instituted.

The raison d'être of *Vana Mahotsava*, it must be clearly understood, is not based on physical or economic grounds, but on grounds which are purely psychological. When a humble peasant plants a tree in front of his hut, or when a community plants trees on the threshing floor and along village roads, the objective is only to provide shade and shelter. School children plant trees not for profit but for aesthetic reasons. Trees planted near roadside wells, places of worship, and in burial grounds have a motif, a personality, and an entity of their very own. They do not lend themselves to economic appraisal. The complaint against the slender content of this national festival voiced in the "Manchester Guardian" betrays lack of appreciation of the aim in view. For, after all, this symbolic planting is by no means a substitute for large-scale afforestation measures, regeneration of forests, and other silvicultural operations carried out by the Forest Departments in various States as part of their usual routine.

The new policy directs pointed attention towards the reconditioning of hills and dales, the immobilization of the Rajputana desert, the prevention of the encroachment of sea-sands on coastal tracts, the rationalization of shifting cultivation, and the control of soil erosion in general.

The policy legislates for the functional classification of forests such as "protection", "national" and "village" forests, the objects of management of which concern themselves in the main with the protection of hillsides, the production of timber for the needs of the nation, and provision for the needs of the cultivator. Special indication has been provided in respect of the principles to be observed in the management of grazing. Attention has also been drawn to the protection of our rich heritage in wild-life.

The national policy calls specific attention to the need for forest research, forest education, and forest legislation to ensure efficient administration of forests. It lays special stress

on securing popular goodwill and recommends formation of co-operatives among the people, to instil in them a direct interest in the forests, the borders of which they inhabit.

Leaving unfettered the discretion of States Governments in the matter of detailed administration of forests, the national policy purports to lay down only the broad fundamental principles underlying forest management. Incidentally, the forest policy of India is in accord with that enunciated recently by the Food and Agriculture Organization of the United Nations.

The Central Board of Forestry constituted at the ministerial level provides a convenient instrument for the implementation of the national forest policy of which we might well be proud.

During the last two thousand years India has gone through political vicissitudes of a varied character which only affected the pattern and the symmetry of the design of society, not the pith and the core of its life. The country-side has remained blissfully unconcerned with the change in the political scene. What, however, is a matter of vital importance to the life of the nation is the change brought about in the physical conditions around us by our own improvidence. The Rajputana desert represents a canker in the right lung of India. The rapid run-off of the rain-water down the Himalayan slopes saps the country of its very life blood, and the loss of soil deprives it of its sole means of sustenance.

The fate of India hangs not in the political, but in the physical balance. Our future is tied up with the maintenance of the equilibrium of the inexorable forces of Nature which brook no interference. They act relentlessly, without pity, without mercy. The shape of things to come a couple of hundred years hence will depend upon how we conserve our soil, how we save our perennial springs, how we organize our physical defences against Nature, and how, in short, we protect our forests.

[*By kind permission of the Editor, "The Statesman"*].

THINNING RESEARCH IN INDIA

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Though the earliest thinning research experiments of India date back to 1900, yet serious attention was paid to this important branch of forestry research, only in the twenties. The subject has been discussed at successive Silvicultural Conferences commencing from 1929. Most of the earlier investigations proved defective from the view-point of initial comparability, proper design, precision of prescriptions, and continuity of treatment. Later it was recognized that the ideal solution would be to lay-out an adequate number of sample plots for each species and for the different thinning treatments, so that "Multiple yield tables" could be prepared to permit direct comparison between the different treatments. In pursuance of this idea, many permanent sample plots have been opened for many species, but in respect of some of our important species all age and height calsses have not been covered. Steps are being taken to remedy this. Multiple yield tables for *Cedrus deodara* covering four grades of ordinary thinning were compiled in 1934, and those for *Tectona grandis* and *Pinus longifolia* are under compilation.

It was soon realized that the above ideal method would involve the opening of many sample plots and measurements over a long period of years. However, to obtain valuable information in a short period and at a much less cost, it was thought that pairs and sets of comparable plots, receiving different thinning treatments would suffice. Such plots were laid out after the third All-India Silvicultural Conference, 1929. In the next 15 years, 93 sets of comparative thinning plots with a total of 407 sample plots covering 27 species were started in different parts of the country. Quite a large number of these plots are in Burma and Pakistan which are now independent countries.

Details of the plots now situated in India are given in the statement given below :—

Species	Statement of thinning research plots in India					
	Total laid out		Abandoned or closed		Current	
	No. of sets	No. of plots	No. of sets	No. of plots	No. of sets	No. of plots
Acacia catechu (plantation) ..	1	2	..	..	1	2
Canarium euphyllum (in mixture)	1	6	..	..	1	6
Casuarina equisetifolia (plantation)	3	54	..	..	3	54
Catalpa sp. (plantation) ..	1	2	..	..	1	2
Cedrus deodara	6	22	1	7	5	~~15~~
Cleistanthus collinus (in mixture)	2	9	1	5	1	4
Cryptomeria japonica	1	3	..	..	1	3
Hopea parviflora	1	3	..	..	1	3
Lagerstroemia hypoleuca ..	3	24	2	18	1	6
Macaranga denticulata ..	1	2	..	..	1	2
Pinus excelsa	4	10	..	..	4	10

(*contd.*)

Species	Statement of thinning research plots in India					
	Total laid out		Abandoned or closed		Current	
	No. of sets	No. of plots	No. of sets	No. of plots	No. of sets	No. of plots
Pinus longifolia (plantation) ..	4	61	1	12	3	49
Populus ciliata	1	2	1	2	..	..
Pterocarpus dalbergioides (plantation)	1	2	..	..	1	2
Pterocarpus dalbergioides (in mixture)	1	6	..	..	1	6
Shorea robusta (coppice) ..	2	17	..	6	2	11
Shorea robusta (plantation) ..	8	23	1	3	7	20
Tectona grandis (plantation) ..	10	100	3	27	7	73
Terminalia myriocarpa (plantation)	1	3	..	..	1	3
TOTAL ..	52	351	10	80	42	271

These investigations deal with various aspects of thinnings in evenaged crops. They vary in design and lay-out from sets of two to three plots to randomized blocks and factorial designs, involving 6 to 54 plots in each case. Majority of these are concerned with the intensity of thinning, i.e., the different types of thinning and their grades. Others aim at finding out the best thinning cycle keeping the grade of thinning constant. Yet others seek to determine the best stage for the first thinning of young crops, under different planting espacements. The commonest type of thinning experimented on is the 'ordinary' or 'low' type, with its various grades ranging from 'A' to 'E', as per standard definitions of the terms adopted in India. A few of the experiments deal with 'crown' thinning while properly designed replicated sets of plots comparing Heck's 'free' thinning and Craibs 'advance' thinning with different grades of ordinary thinnings are in existence for *Tectona grandis* and *Pinus longifolia*.

It might be stated here that some of the existing investigations suffer from lack of initial comparability. A much larger number have unfortunately been spoilt for want of proper maintenance in later stages due to various causes.

As thinning investigations are essentially long term studies it is felt that majority of our investigations have not been maintained long enough to yield reliable results. Tentative conclusions have, however, been drawn in some cases and these will be described now :—

Teak – (*a*) *Periodicity of thinnings*—Experiments conducted in high quality (All-India Site Qualities I and II) plantations in Madras indicate that thinnings in such crops are best started at a very early age and repeated at short intervals in the early part of the crops' life. Based on the results of the experiments the present practice in that State is to carry out thinnings in high quality teak plantations at the ages of 3, 6, 10, 18, 30 and 44 years. An investigation in Coorg (Site Quality IV/V) indicates that with 6 × 6 feet initial espacement the first thinning may be easily postponed till the crop is about 11 years, while another investigation in Bombay indicates that in V quality crops and with 9 × 9 feet planting espacement, the first thinning may be done at the age of 13 years.

(*b*) *Type and intensity of thinning*—The existing investigations compare the heavy grades of ordinary thinnings with each other and with "free thinnings" as advocated by Heck and "advance thinnings" as advocated by Craib. The investigations will have to be continued for some time more before definite conclusions can be drawn. Comparison of advance thinning, with the routine district practice, which approximates to the 'D' grade of ordinary thinnings, indicates, that the former appreciably enhances the rate of diameter growth. Thus a breast height top diameter [average of 50 biggest trees per acre] of 9·5 inches has been produced in 15 years under the district practice and in 11 years under "advance" thinnings.

Statement showing the progress of diameter and height under the two treatments

Age	Top diameters in inches		Top heights in feet	
	Advance thinnings	'D' grade ordinary thinnings	Advance thinnings	'D' grade ordinary thinnings
2 years ..	1·8	1·9	18	20
8 ,, ..	7·5	7·0	49	51
15 ,, ..	10·9	9·5	63	64

Statement showing the production of useful basal area and total volume till the age of 15 years

Treatment	Production of useful basal area in sq. ft.	Corresponding production of total volume (stem timber and stem small wood) in c. ft.
Advance thinnings ..	59	865
Ordinary 'D' grade thinnings ..	75	1,434

Note.—Stem timber is the under bark volume of the main stem up to the 8 inches, O.B. diameter limit and the stem small wood is the overbark volume of the main stem between the O.B. diameter limits of 8 and 2 inches.

There has also been a slight rise in height increment but the basal area and total volume increments have registered a considerable fall. Some specimens of the timber from the advance thinning plots have been examined at the Forest Research Institute, Dehra Dun, and it was found that there was no significant difference in the mechanical properties of the two specimens. It would thus appear that the rotation age of teak could be appreciably reduced by introducing advance thinnings practice. But the sacrifice in total production and the influence on the soil fertility will, however, have to be carefully considered before a final decision is taken.

Another investigation, comparing the influence of normal, heavy and very heavy first thinnings in low quality (IV/V All-India Site Quality) teak plantations in Coorg indicates that the heavier grades of thinning result in greater diameter increment and can be introduced without appreciably affecting the basal area increment.

Treatment	Basal area increment in square feet	Top diameter increment in inches
Normal thinnings ..	70	3·9
Heavy thinnings ..	60	3·7
Very heavy ..	64	4·5

It is interesting to note that the poles under the heavy and very heavy grades of thinning developed thick branches on the lower parts of the stems in the beginning. Natural pruning, however, took place subsequently and at about 20 years age, no appreciable differences were noticeable in the length of the clean boles.

Pinus longifolia—The three "comparative thinning" investigations for this species were all laid out in the young high quality *chir* plantation crop in the New Forest estate of the Forest Research Institute, Dehra Dun. One of these deals with thinning cycle and the other two with the intensity of thinnings. The thinning cycle investigation, which is an experiment to study the effect of 4, 8 and 12 years thinning cycles on young *chir*, when subjected to the 'D' grade ordinary thinnings, indicates that the 4 years thinning cycle results in maximum diameter, basal area and volume increment and the largest number of stems in the upper diameter classes.

Statement showing the increment in top diameter, basal area and volume between 10 and 26 years age and the number of stems in the top diameters at 26 years age

Treatment	Top diameter increment in inches	Basal area increment in square feet	Volume increment in c. ft.		Number of stems in top diameter classes at 26 years age			
			Stem timber	Stem small wood +stem top	8″–10″	10″–12″	12″–14″	14″–16″
4-year thinning cycle ..	5·7	108	1572	data not available	113	52	19	5
8-year thinning cycle ..	5·5	108	1635	4830	105	84	14	..
12-year thinning cycle ..	4·8	87	1174	4254	121	55	3	..

The diameter increment shows a progressive decrease with the longer thinning cycles. The basal area and volume production remain practically constant with both 4 and 8 years thinning cycles, but a sharp fall is registered in both the factors, under the 12 years thinning cycles. The investigation also indirectly indicates that with such high quality crops, thinning intensities lighter than the 'D' grade would result in fall in total production and should, therefore, be avoided.

The second investigation deals with the effect of 'free' thinnings as compared with the 'D' and 'C' grades of 'ordinary' thinnings. Only tentative conclusions can be drawn now. The free thinning has resulted in bigger diameter increments as compared with the other

two treatments. The basal area increments have remained unaffected. It may be mentioned here that these differences have not turned out to be statistically significant inspite of the fact that we have got replications of the three treatments.

Statement showing the development of top diameter and basal area increment under the three treatments

Treatment	Top diameters at 23 years age in inches	Basal area increment from 9 years to 23 years age in sq. ft.
Free thinning ..	10·6	88
'D' grade thinning ..	10·0	80
'C' grade thinning ..	10·0	92

Another investigation was carried out at the Forest Research Institute to study the effect of early spacing of *Pinus longifolia* crops resulting from dense sowings in lines 6 feet apart. Five-year old good quality crops (with crop diameter and crop height of 19 inches and 9 feet respectively) were thinned down to 545 and 800 stems per acre and unthinned control plots were kept for comparison. In the heavily thinned plots thinnings were found to be necessary at the age of 14 years. The intensity of thinning was found to have a high positive correlation with diameter and stem timber increment.

Statement showing the production of diameter and volume under the three treatments at the age of 14 years

Treatment	Crop diameter in inches	Volume in c. ft.	
		Stem timber	Total volume
545 trees per acre ..	6·5	169	2276
800 trees per acre ..	5·8	17	2696
Unthinned ..	3·9	7	3696

The total volume was maximum in the unthinned control, which, however, was poor in form and in a very unhealthy condition. Thus early specing is fully justified in crops intended to be grown on fairly long rotation to produce timber. Where small timber or fuel wood is the aim such treatment is not beneficial.

Shorea robusta (Plantation)—The investigations relating to this species were started with high quality sal crops, five to six years old and they are still continuing. Various grades of thinnings with unthinned controls have been tried. The indications are, that the diameter

increment is the minimum in unthinned crops and rises with an increase in thinning intensity. The basal area and total volume (up to 2 inches overbark limit) also rise till they reach a maximum value somewhere between C to C/D grade of thinnings and start declining thereafter. From the point of view of stem timber volume (up to 8 inches overbark limit) the fall is not noticeable up to the D/E grade. It may, therefore, be concluded that the 'C' or 'C/D' grade would give the best results, if production of fuel or small timber was aimed at, but the 'D' or 'D/E' grade is to be preferred if the aim was to produce large sized timber.

Plots 17 to 19 of Jalpaiguri Division, 6 to 21 years age

Treatment	Top diameter increment in inches	Basal area increment in sq. ft.	Volume increment in c. ft.	
			Stem timber	Total
Unthinned control	5·3	60	556	2887
'B' grade thinning	6·0	93	313	2810
'C' grade thinning (6 to 10 years) } 'D' grade thinning (15 to 21 years) }	6·3	114	139	2320

Plots 11, 12 and 13 of Kalimpong Division, 10 to 25 years age

Treatment	Top diameter increment in inches	Basal area increment in sq. ft.	Volume increment in c. ft.	
			Stem timber	Total
'C/D' grade thinnings ..	5·1	90	931	3139
'D' grade thinnings ..	5·3	83	793	3052
'D/E' grade thinnings ..	5·4	77	900	2278

Plots 26, 27 and 28 of Buxa Division, 6 to 21 years age

Treatment	Top diameter increment in inches	Basal area increment in sq. ft.	Volume increment in c. ft.	
			Stem timber	Total
Unthinned control	5·5	80	143	2860
'D' grade thinning	6·0	83	462	2987
'C' grade thinning	6·7	130	638	3202

Cryptomeria japonica—Ordinary 'C' and 'D' grade thinnings have been tried with an unthinned control. It appears that between the ages of 5 and 21 years, the 'D' grade thinning results in maximum diameter, while the basal area production does not appear to be affected by the treatment.

Statement showing the diameter and basal area increments between the ages of 5 and 21 years

Treatment	Crop diameter increment in inches	Basal area increment in square feet
'D' grade thinnings ..	6·4	187
'C' grade thinnings ..	5·0	158
Unthinned control ..	2·9	170

It may, however, be added that the rate of growth under Indian conditions is very much faster than in the natural habitat of the species, and the resulting wood having poor strength qualities has little timber value. The species should be subjected, therefore, only to very light thinnings.

Cedrus deodara—Out of the six sets so far laid out initial comparability was established only in the case of one set which aimed at an investigation into the effect of different espacements in young deodar crops. The experiment has proved that an increase in the early espacement up to the extent of 10 × 10 feet has a beneficial effect on the development of diameters, heights and crowns of the resulting crops. But as the lower branches have a strong tendency to persist, wide initial espacements should be coupled with pruning.

Statement showing the effect of thinning natural regeneration of Cedrus deodara (age 11 years) to different spacings (Period of observation 10 years)

Spacing in feet	Average diameter in inches	Average height in feet	Average crown width in feet	Average length of clean bole in feet
10 × 10	6·7	38·5	10·9	7·5
8 × 8	6·0	34·3	9·3	8·9
7 × 7	5·9	35·2	8·9	11·4
6 × 6	4·9	31·0	7·2	11·9

Classification of stems—An accurate and objective description of the various types and grades of thinnings presupposes a suitable system of classification of the stem composing a stand. Such a classification for even-aged high forest, based primarily on the relative position of individual stems in the main canopy, was adopted in 1929 by the 3rd All-India Silvicultural Conference. Some additions, found necessary especially for the purposes of research work, have been introduced from time to time. The approved tree classification is now as follows :—

Abbreviations

I. *Dominant trees* (D) ; including all trees which form the uppermost leaf canopy and have their leading shoots more or less free. These may be subdivided according to the position and relative freedom of their crowns into :— D

(*a*) *Predominant trees* (D1) ; comprising of all the tallest trees which determine the general top level of the canopy and are free from vertical competition. D1

Abbreviations

(*b*) *Co-dominant trees* (D2); comprising of the next tallest trees which have their leaders quite-free but only attain 5/6 of the average height of D1. — D2

Both the sub-classes may further be classified according to their vigour and soundness or otherwise into :—

(*a*) Trees with normal crown development and good stem form. — a

(*b*) Trees with defective stems or crowns, e.g. :—

1. Trees with crown space cramped by neighbouring trees. — b1
2. Badly spaced old advance growth. — b2
3. Trees with forked leader and similar defects. — b3

(*c*) Trees with very defective stems or crowns, i.e., with the same defects as (b) to such an extent that they are of little or no present value or promise. — c

(*d*) Whips.

Trees with very thin bole and very restricted crown incapable of existence without the support of the neighbouring trees. — d

II. *Dominated trees* (d); which do not form part of the uppermost leaf canopy, but the leading shoots of which are not definitely over-topped by the neighbouring trees. Their height is about 3/4 that of the tallest trees :—

(*a*) Trees with normal crown development and good stem form. — da

(*b*) Trees with defective crowns or stems. — db

III. *Suppressed trees* (s); which reach only about ½ to 5/8 of the height of the best trees, with their leading shoots definitely over-topped by their neighbours or at least shaded on all sides by them. A small tree of height typical of suppressed trees standing with its leader free in a chance gap should not be classed as D or d. — s

IV. *Dead and moribund trees* (m). This class also includes bent over and badly leaning trees usually of the whip type. — m

V. *Diseased trees* (k)* including those which are infected with parasites to such an extent that their growth is seriously affected or that they are a danger to their neighbours :— — k

(*a*) Dominant.

(*b*) Dominated and suppressed.

VI. Reproduction or regeneration (r). — r

VII. Overmature (v). The symbol (v) is suggestive of Veterans. — v

The various grades of the 'ordinary' and 'crown' thinnings have been defined in terms of the removal of some of the above classes as under :—

I. Ordinary thinning :—

(1) Light thinning (A grade). V, IV and III classes of trees.

(2) Moderate thinning (B grade). V, IV, III, II(b), D2(d) and D1(d) and occasionally D1(c) classes of trees.

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* The symbol k is proposed as suggestive of canker.

Abbreviations

(3) Heavy thinning (C grade). V, IV, III, D1(d), D2(d), and gradually all II, D2(b) and D2(c) and part of D2(a) and D1(c) classes of trees.

(4) Very heavy thinning (D grade). V, IV, III, D1(d), D2(d) and gradually all II, D2, D1(c), D1(b) and part of D1(a) classes of trees.

(5) Heaviest thinning (E grade). This is the heaviest thinning that can be done in a crop without making a permanent gap in the canopy, thereby passing on to an increment felling.

II. Crown thinning :—

(1) Light crown thinning (L.C. grade). V, IV, D2(d), D1(d) part of D2(a), D2(b), D2(c) and D1(b) and a great part of D1(c) and some D1(a) classes of trees.

(2) Heavy crown thinning (H.C. grade). V, IV and all D2 and D1 hindering *élite* stems.

Note.—V, IV and III may be left if their removal is of no economic or hygienic value.

Advance thinning—The advance thinning is carried out on the principle of anticipating crown competition, subject to the fundamental condition that the operation should at no stage lead to a permanent gap in the main canopy. In the case of 'free' thinnings a limited number of *élite* stems, uniformly distributed over the area, are selected in the early stages of the life of the crop. Their actual number depends on the number of stems to be left in the main crop at the rotation age. Some margin is allowed for future casualties. Thinning operations are primarily carried out for the benefit of these *élite* stems, the unthinned patches being subject to ordinary heavy thinnings after the requirements of the *élites* have been fulfilled.

Control of thinnings—A number of attempts have been made to control the intensity of the different grades of ordinary thinnings on the basis of various mathematical checks. Most of these checks are based on the published yield table figures though some depend on the basal area increment or a combination of the two. The utility of such checks for ensuring continuity in treatment is appreciated especially in view of the frequent changes in the research personnel. Past experience with most of these checks, however, has not been happy and it is realized that they have to be used with much circumspection. The yield table figures, in majority of cases, are a good approximation of the 'C' grade thinnings. The 'B', 'D' and 'E' grades are equated with 120, 80 and 60 per cent of yield table numbers, a ten per cent allowance being made in either direction. The thinning operation is primarily carried out in accordance with the standard silvicultural definition of the grade and the mathematical check is then applied to decide the fate of the border line cases. Of the various checks based on the yield tables, that based on the number of stems and average diameter (with due allowance for the site quality) has been found to give the most consistent results. The checks depending on the basal area increment have usually broken down for a variety of reasons.

Thinnings are carried out when the silvicultural condition of the stand demands the same. The presence of suppressed and dominated trees and competition between the crowns of adjoining stems are taken as indications for carrying out the operation. Attempts have been made to time successive thinnings on the basis of crop basal area increment. These have invariably turned out to be unsuccessful because the rate of basal area increment changes with the age of the crop and its magnitude also varies under the different thinning grades.

UTILIZATION OF WASTE WOOD

PART II

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INTRODUCTION

The present report constitutes a continuation of an earlier report on "Utilization of wood waste – Board Manufacture" presented at the first seminar. In that report I had dealt with only one, but an important channel into which the wood waste problem has been rightly directed, both here in the United States as well as in Europe. The limiting factor, however, which has prevented a more successful and extensive trend in this direction is the question related to economics. It will be remembered from my earlier report that the smallest economically operating plant engaged in the manufacture of wallboard, using softwood planer shavings mixed with 25% saw-dust and resin as a binder, utilizing 16 to 20 tons of waste wood and capable of producing 25,000 to 30,000 square feet of ¼ inch boards daily, requires a working equipment estimated at $81,400 excluding the building construction interest, taxes, etc., on the capital outlay.

Generally speaking the problem of waste wood utilization is very closely knit with that of economics. A manufacturer of wood products would always insist that a product from the wood waste has a good chance of adding to the profit size of his ledger before he can be expected to embark on the project. This attitude is, of course, justifiable. Availability of the raw material and transport constitutes another limiting factor determining the feasibility or otherwise of waste wood utilization anywhere in the world. It is rather unfortunate that a large volume of the unused wood lies in the forests. Economics dictate better possibilities for waste material at the mills. Certainly, if the problem of utilization of the wood waste at hand is rendered difficult due to financial consideration – how much more difficult it would be to collect the wood waste from the forest ? This, however, should not convey to you the wrong impression that the problem of waste wood utilization is impossible of solution. Far from it. The above facts only illustrate the obstacles to be overcome. The importance that has been recently attached to this unexplored mine of raw material and the research that is under way only shows that the problem has been taken as a challenge by the science and industry alike.

This report is, therefore, confined to a consideration of other possibilities of outlets for the waste wood besides the board manufacture and involves a discussion of two major types of wood waste utilization, e.g., one, *the chemical utilization* and two, *the mechanical utilization*. Each of the two types is a broad field in itself and no attempt will be made to go into the details of each. However, an effort will be made to point out the most important outlets under each category and give you a general picture of the possibilities that exist.

A. CHEMICAL UTILIZATION

From a chemist's point of view, the wood that is considered as "waste" is no different from wood that is used for other purposes. An engineer too, looks at all wood substance as a form of organic matter with potential value. Chemically, therefore, the utilization of waste wood is based on its organic constitution and involves the breaking up of the organic substances contained in the wood. It would be worth while, therefore, to consider in brief the chemistry of wood.

Chemistry of wood—A typical soft wood such as spruce or fir contains about 67% of carbohydrates, 27% lignin and 6% extractives ; and a hardwood such as maple contains about

73% carbohydrates, 22% lignin and 5% extractives (14). The carbohydrate portion of wood includes two types of organic materials – (1) the alpha cellulose and (2) the hemi cellulose. The alpha cellulose which comprises about 50% of the wood is resistant to mild chemical treatment and is made up almost entirely of polymers of glucose. The hemi cellulose on the other hand, is readily broken down by mild chemical treatment, is made up of polymers of several different types of sugars including pentoses, hexoses, uronic acids, methylated substances and acetylated substances. Hemi cellulose of hardwoods consists mostly of pentosans and that of softwoods of hexosans – which on hydrolyses yield pentose and hexose sugars respectively.

Generally the greatest return of wood waste from chemical utilization could be realized by converting it into pulp or fiber for paper or boards. But this is closely knit with important considerations such as location of wood waste, quality of wood waste as affected by presence of bark, high cost of machinery, etc. The chemical outlets may, therefore, be subdivided into:

(*a*) processes that result in products that own their value to fibrous or structural properties of wood, e.g., pulp paper, moulded articles; and

(*b*) processes which produce chemicals such as wood molasses, fodder yeast, industrial alcohol, glacial acetic acid.

1. *Pulp products*—It will be remembered that pulping also formed an integral phase of board manufacture. Theoretically, any form of wood waste could be reduced to chips which constitute a potential raw material for pulp and paper. Wood waste in the form of slabs, edgings, trim, chips, shavings and veneer mill waste as produced in the various woodworking operations could be utilized. Quality of waste wood is a very important factor in this direction as the best of quality alone offers the best financial returns. Economics will not permit the use of mill scrap that contains too much of bark in relation to its solid wood content as it has been found very difficult and expensive to debark the slabs.

The types of products into which wood wastes are being utilized in limited amounts at present are (16).

(*a*) Chemical pulps,

(*b*) Semi-Chemical pulps,

(*c*) Mechanical or ground wood pulps, and

(*d*) Coarsely fiberized wood.

All these are used in the various kinds of paper, roofing and saturating felts.

(*a*) *Chemical pulps*—Wood wastes frequently produce pulps inferior to those made from round wood – but they offer an important source of raw material to supplement the wood supply of a pulpmill. A considerable tonnage of kraft pulp is being produced from saw-mill waste in the form of slab and edgings. This material is either chipped at the saw-mill and sold to the pulpmill as chips or is transported to the pulpmill in whole form where it is chipped in special chippers and made into pulp for use in bag stock, towelling and kraft speciality papers. Soda pulp is also being produced from both hardwood and softwood veneer mill waste. The amount of bark present is an influencing factor in the type of pulp and the kind of end product for which the waste material can be used.

For the production of kraft pulp to be used as cheap wrapping and in container board, where cleanliness of the pulp is not of major importance, considerable bark can be tolerated. But not so in the clean light colored pulps by sulphite process – in the later even a little bark is objectionable. It is stated that (6) over a range of 0–25 percentage of bark, the active alkali required per ton of pulp is directly related to the percentage of bark and increases at the rate of 13·4 pounds of active alkali per one per cent of bark.

(*b*) *Semi-chemical pulp*—Semi-chemical pulping may be broadly defined as a two stage pulping process involving chemical treatment to remove part of the lignocellulose fiber bonding

material and mechanical refining to complete the pulping action. This process has been found particularly suited to the pulping of wood wastes – both of hardwoods and softwoods.

Experiments at the Forest Products Laboratory (11) have indicated that a mixture of hogged mill waste varying from saw-dust to pieces of slabs, containing about 30% bark and with about 10% hardwood, when cooked by the semi-chemical process, can be converted into a substitute for kraft and used to "dilute" the kraft finish in container liner – with the mixture having higher shearing strength values and better bending qualities.

(c) *Ground wood pulp*—Ground wood pulp, obtained by mechanical grinding of wood waste is being increasingly used in the manufacture of corrugating board, bats and towelling paper.

Tops and limbs too could be utilized for pulp-wood – unfortunately they haven't yet found full utilization in this field. One reason is that it requires more labor to produce the material than is required for cutting of the stem wood. There is also some objection to the use of top and limb wood for higher strength papers because the fibers are shorter than those in the stem wood and have a weakening effect on the pulp (21).

Another reason why the "forest waste" is not being harnessed by the pulpmill is the fact that the saw-mill logging contractors as a rule do not indulge in pulpwood logging except when the saw-mill is connected with the pulpmill. Integrated utilization appears to be the answer in this direction and some progress has already been made. The most outstanding example is that of Longview Fiber Co. of Longview, Washington (1). This plant, established in 1944 with the express purpose of using only the waste woods has pulped over 625,000 cords of Douglas fir refuse both from the forests and from the larger Long Bell Lumber Co. of the same city.

2. *Hydrolysis of wood waste*—Hydrolysis of wood waste shows the widest possibilities in the field of chemical utilization. It consists of hydrolysing waste wood substances into simple sugars by treating with sulphuric or hydrochloric acid. Two methods have been evolved – (1) using a strong 72% sulphuric acid or 45% hydrochloric acid at room temperature and (2) using dilute acids at higher temperatures of 150° to 200°C.

Treatment with strong acids, although used in Germany is disadvantageous because of the large amount of the acids used and the expensive equipment required. The dilute acid processes for converting wood cellulose to sugars involve the use of 0·5 to 1% acid solution at 175° to 190°C. A process developed by the Forest Products Laboratory and known as the Madison wood sugar process (14) used 0·5% sulphonic acid pumped continuously through a charge of wood at temperature 150° to 185°C. was given sugar recovery of 60 to 80% of the amount of the carbohydrates in the wood.

In its application in industry the hydrolysis of waste wood has been channelled into the production of the products stated below.

(a) *Wood mollasses*—The production of wood molasses from hydrolized wood is accomplished by neutralizing the acid with lime at the pH at which sugars are most stable under pressure at 130°C. concentrating the solution and filtering it. The solution is further concentrated to produce a 60% sugar solution and again filtered giving a clear amber viscous liquid that has about 60% total solids and constitutes what is known as wood molasses.

Wood molasses has been claimed to be equal to cane or beet molasses in most cases for live stock feeds (18). The manufacture of wood molasses has been carried on in Europe for some time and now a small pilot plant has been set up in the U.S.A. too, in the Tennessee valley.

The cost of molasses has been estimated by Locke (18) at 12 cents per gallon but this is probably a low estimate. The north-eastern Wood Utilization Council (5) estimates the

production cost per gallon in a 20 ton per day plant to be around 30 cents per gallon. It, however, appears that so long as supplies of black strap mollasses can be delivered cheaply in the United States, the production of wood molasses would remain an unprofitable business.

(*b*) *Fodder yeast*—Another industrial application of hydrolysed wood which shows promise is the manufacture of fodder yeast. It is produced from the hydrolysed wood by neutralizing the acid to pH of 4 with lime, filtering to remove the precipitate, adding nutrients for the growth of yeast and then introducing the filtrate with a special yeast propagator. The yeast is removed from the spent liquor by centrifuging and is then cleaned and dried.

Fodder yeast has been found to have a very high vitamin B content and has been economically produced in large quantities in Germany at a cost as low as 5 cents per pound. This production reached its highest development in Germany during World War II when approximately 9,000 tons of food yeast per year were obtained. A pilot plant at Rinelander, Wisconsin, has recently gone on commercial production of yeast from wood (3).

(*c*) *Industrial ethyl alcohol*—Industrial ethyl alcohol may be produced from wood sugars obtained by hydrolysis by neutralizing the acid solution with lime to pH 5, filtering to remove calcium sulphate, cooling to 87°F. adding yeast nutrients and inoculating with an acclimatized yeast. It is stated that Germany's production was 70 million gallons of ethyl alcohol annually during World War II by this process from wood. It was used for airplane fuel and for production of butadiene required in synthetic rubber. In the U.S. there is a huge big plant producing ethyl alcohol at Springfield, Oregon, supplying 15 to 20,000 gallons per day to the Pacific coast synthetic rubber project at Los Angeles.

(*d*) *Hydrolysis of waste for plastics*—The manufacture of moulding powders and board material from the acid hydrolysed saw-dust or chips has been studied (13) with the purpose of furthering the utilization of wood waste. In the hydrolysed wood the per cent of lignin content is increased with the breaking up of the carbohydrates into soluble sugars. In addition, lignin is partially converted into a form in which it functions as a plastic. It has been estimated with short hydrolysis the residue contains as much as 60% of lignin – nearly double the amount of lignin originally present in the wood substance. Thus, when hydrolysed, saw-dust is reduced to a powder and it serves as a semiplastic filler for phenolic moulding compounds – similar to wood flour filled phenolics.

Only a few of the many uses of hydrolysed wood have been given here. Other organic solvents and chemicals could also be produced from hydrolysed wood by fermentation methods.

3. *Wood distillation*—Wood distillation constitutes probably the earliest chemical process that appears to have been applied to wood for conversion into charcoal. And although the need for charcoal as fuel has declined during the last twenty years in the U.S.A. on account of other fuels, there is nevertheless an almost continuous demand for the same. In the earliest days, the charcoal was produced in the "pit-kiln" form. This is practised even up to this day in many of the eastern countries where labour is untrained and cheap and mechanical equipment expensive and therefore unjustifiable. Besides this type of crude conversion, constitutes wasteful utilization on account of the loss of chemicals that could otherwise be obtained as by-products of the conversion.

Destructive distillation is essentially a carbonization process. Although it is not an uncommon commercial operation in the U.S., there are relatively few plants which operate on wood waste alone. During the recent years the wood distillation industry in the U.S., has been faced with an acute problem of the diminishing supplies of raw material (9). It is here that the wood waste can be harnessed to ease the situation. The Ford plant at Iron Mountain, Michigan, is an excellent example of what can be done with wood waste by distillation (8).

This particular plant has approximately 400 tons of scrap per day in the form of slabs edgings, trimmings of maple, birch and a small quantity of elm, ash and oak all mixed together with different moisture content. Destructive distillation appears to have offered the most profitable returns for utilizing the waste material.

Although similar carbonization methods are employed and the charcoal produced is almost the same, destructive distillation has been divided into two different categories : one for the distillation of hardwoods and the other for softwoods, on account of the resinous nature of the later resulting in different by-products. The operation itself is also a two step operation consisting of :

(*a*) Drying and carbonization of wood and
(*b*) Subsequent refining of the crude liquid products.

Beech, birch, maple, ash, hickory, gum, tupelo and oak are some of the hardwoods which constitute the chief source of raw material in the first category and yield in addition to charcoal, acetic acid, methenol and acetone. Softwoods on the other hand – especially resinous woods, yield turpentine, pine tar, taroils, solvent oils, etc. The distillation processes for both the hardwoods and softwoods in a simplified form are given in Figs. I and II.

Fig. I. By-products of Hardwood Distillation (9)

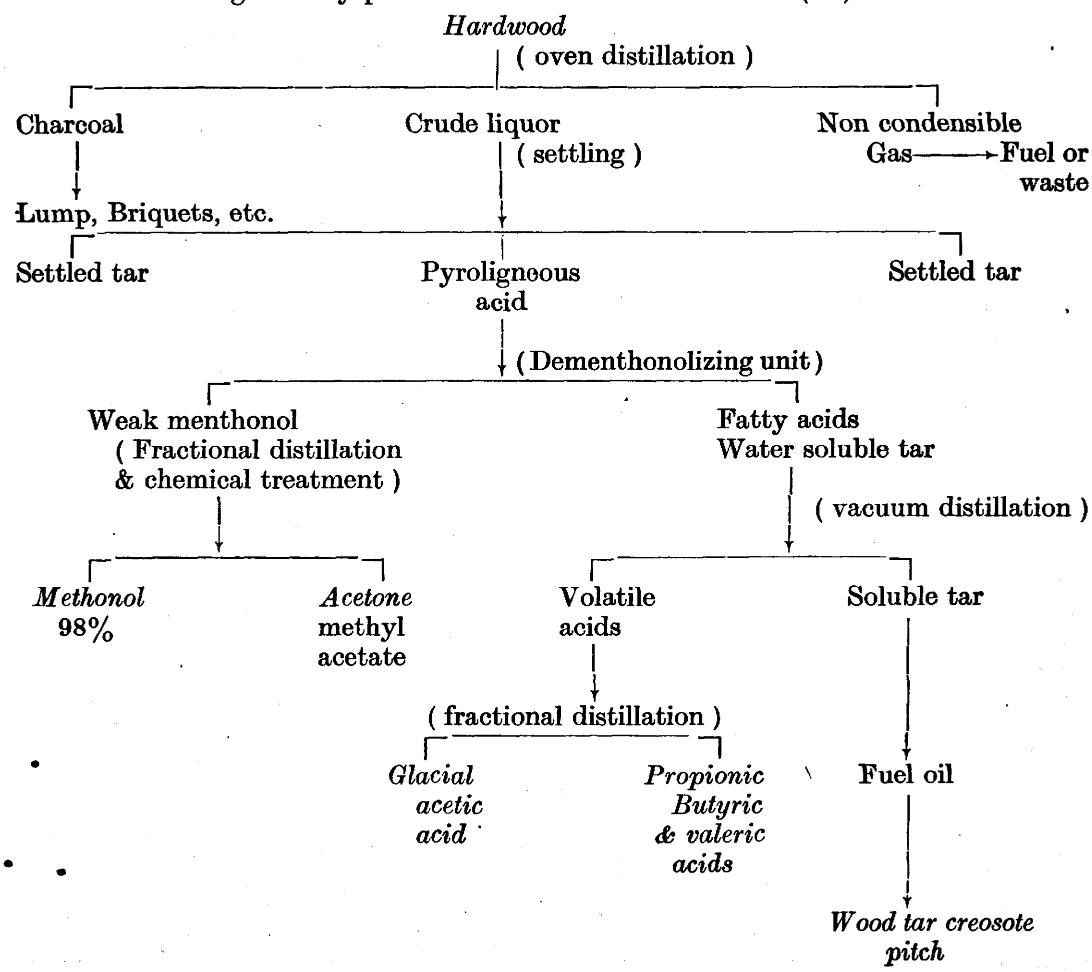
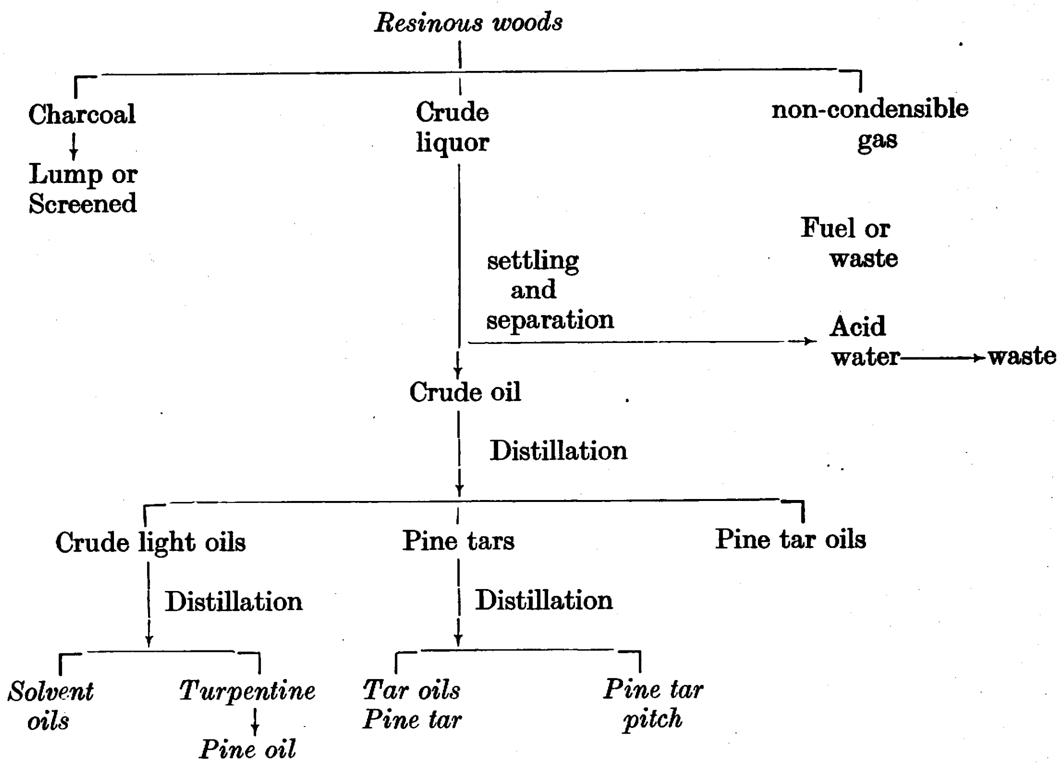


Fig. II. By-products of Resinous wood Distillation (9)



Considerable progress has been made in the distillation processes since 1928 as a consequence of keen competition by similar synthetic products produced at lower costs. The distillation break up chart shown above constitutes a modified process eliminating the indirect recovery of acetic acid as calcium acetate. There is, however, a lot of scope yet in the development of these processes. Various types of continuous processes of wood distillation have been recently developed in Europe. Most favourable aspect of these processes is the "Continued" carbonization which reduces handling and plant labor and also reduces maintenance charges.

A further development has been in the form of a semi-portable distillation unit that has been designed by Dr. E. Strupp in Switzerland (7). This movable installation does not differ basically in its construction from the large stationary units. They are, however, lighter and built in parts in such a way that they can be transported by means of trucks and easily assembled. Thus the unit could even be set up in the forest areas utilizing the wood waste available. The cost of such a plant has been estimated at $8,813 inclusive of electric installation, power supply, etc., and is said to have a daily output of 6,500 pounds of charcoal utilizing an equivalent of 5 cords of wood (7).

B. MECHANICAL UTILIZATION

The mechanical utilization of wood waste includes a number of uses in which the chemical structure of the wood substance remains unaltered. This would mean utilization of wood waste either in the form it occurs at the various saw-mills, and woodworking industries or after

being physically modified as regards the shape, size, form, etc. The best example of mechanical utilization would be the use of the waste directly as fuel. But this is an old time beaten outlet which has stood the test of time over and over again. Suffice it to say that it is universal in application and although the metropolitan and highly industrialized zones may not consider it a "deluxe" fuel for their use, it is bound to stay in the rural areas. For the purpose of this report, however, this outlet of mechanical utilization will be omitted so as to consider at some length other possible outlets which appear to have a bright future.

Broadly these outlets will be considered under the following headings:

1. Briquetting of wood waste,
2. Manufacture of wood flour,
3. Manufacture of small dimension stock,
4. Wood waste as soil conditioner.

1. *Briquetting of wood waste*—Briquetting constitutes consolidation and densification of wood waste ground to fine particles, into convenient sized units to be used as fuel. The successful preparation of fuel briquets from saw-dust, shavings, hogged wood have opened up new fields of wood waste utilization in the U.S. Briquetting is no new process. It has been in use in some of the European countries for many years. The reason why similar efforts failed in the U.S. in the past was on account of the cheapness of other fuels, a plentiful supply of solid firewood and the undeveloped briquetting techniques (4). With the growing awareness of waste wood utilization and development of successful techniques, the briquetting of wood waste appears to hold the widest possibilities. Because briquets have a high density and less moisture content they have a higher heat value than wood and are less bulky. Besides they are clean, produce no smoke, and have a low ash residue (21).

Wood is one of those rare products of nature that has self bonding properties when [illegible] log" briquetting machine, which packs into cylindrical briquets the wood waste (saw-dust, shavings and other hogged wood reduced to oatmeal size) under a high pressure of 25,000 to 35,000 psi without the use of any artificial binders. The functional temperature at that high pressure generates sufficient heat which produces the necesary plasticising action in the wood required for self bonding. The resulting briquets weigh about 8 lbs. and measure $4\frac{1}{8}$ inches $\times$ $12\frac{3}{4}$ inches.

The daily output of briquets on a single machine working 24 hours has been estimated around 10 or 11 tons (21). For profitable returns, continuous round-the-clock production has been found essential. Further since one operator can conveniently handle the output from at least 2 machines it has been found most economical to install a pair of machines. This means a daily production of 24 tons of briquets which in consequence means that a briquetting plant can be economically located only in areas where plentiful waste is available. This constitutes an important limiting factor. A further limiting factor is that since dry uniform wood material is essential, the briquetting plant will have to be raised in the vicinity of a large woodworking industry using dry lumber. Green saw-dust could be used but would require to be processed by a drying method at some expense.

• Walter Letts of Northville, New York has recently perfected another small briquetting machine for making so-called Letts Burnets which are small cylinders of compressed saw-dust without binders, measuring $1\frac{1}{8}$ inches in diameter and cut in short lengths (17). A single head eight tube machine is said to cost $20,000 and a double head machine about $32,000. (21).

A single head machine uses about 3 to 4 tons of saw-dust per 8-hour day, and could be more profitably used for areas with limited availability of suitable raw material.

It would, therefore, be seen the economics constitute an important consideration in this field of waste wood utilization. Broadly speaking the three important requirements for a successful briquetting operation could be enumerated as :

1. continuous and steady flow of raw material;
2. low production costs to enable this type of fuel to compete favourably with other well established fuels; and
3. adequate market to absorb the product.

The cost of "Presto-log" briquets has been estimated around $8 per ton and is expected to be lower where a two machine unit has been established. Garland (12) reporting on the cost of setting up of a two "Presto-log" shoker fuel machines including drying equipment and building complete, estimated it to be $49,525 in 1949.

2. *Wood flour*—Manufacture of wood flour is another promising outlet for the mechanical utilization of wood wastes in limited quantities. Wood flour constitutes wood waste reduced to a very fine particle size (approaching that of cereal flour is size, appearance and texture, etc.) by means of grinders such as stone mills, attrition mills, hammer mills, etc., and sized by means of mechanical or air screening methods. Wood flour is required to meet rigid specifications with regard to distribution of particle size, species included, resin content, moisture content, color, specific gravity, foreign matter, absorptiveness, etc. (19). Often the requirements vary with the use. Among its many uses may be cited plastics, linoleum, explosives, cleaning and polishing, floor covering, etc., the first three being the most important. It is, therefore, essential to explore the markets and find out the specifications before any plans of production are ventured.

Manufacture of wood waste requires considerable technical skill and specialized knowledge as the characteristics of the wood particles are entirely dependent on the skill and method of preparation. Specialized uses of wood flour require that the raw material be separated by species. The species acceptable for wood flour are few in number. White pines (eastern, western and sugar pine) aspen, spruce, hemlock and to a limited scale, balsam fir, and paper birch. Basswood and maple are acceptable for some uses also. But strongly acidic species like oak, and many other species with dark heartwood are considered undesirable on account of the light color required for dynamite, linoleum and plastics. In the dark colored plastics, however, darker colored wood flour could be utilized. In Great Britain some use has been made of teak, beech, cedar and even mahogany in this direction (19).

Thus the technical requirements at present limit down the total amount of wood waste that could be utilized in this channel. Besides this the other limiting factors are (1) the waste should be bark free (2) it must be dry (10 to 12% moisture content) to permit reduction to flour and (3) it should be readily available in sufficient quantities.

The wood flour industry recognizes three grades of wood flour (20). 1. The non-technical grade represents a mesh of 4 to 20. In many cases this grade approaches the saw-dust and is used for floor sweeping compounds, animal bedding, filler for packing breakable items in shipping, ground covering for outdoor events. 2. The technical grade requires wood flour ranging from 25 to 65 mesh size and is used for cleaning furs, as a filler for explosives and linoleum. Usually one species and a high degree of refiners are required (2). 3. The granular-metric grade of wood flour requires a mesh range of 80 to 250. The specifications of this grade

are quite rigid. It is this grade that finds specialized uses and is difficult to produce at competitive costs. It needs to be pointed out here that many of the specifications recognized at present are unnecessarily rigid and are a result of a lack of research and knowledge. Broadly considering the 50 to 140 mesh size with an average around 80 would meet most of the industrial requirements.

Two different methods of manufacture are employed, depending on the condition of the wood waste material to be reduced. If saw-dust and shavings constitute the raw materials the attrition mill is used directly for grinding to the final mesh size. On the other hand if the raw material is in the form of trims, edgings and small blocks, a hammer mill is used to reduce the initial material to chip size and then the attrition mill to grind the same to the final flour size. In the attrition mill, corrugated metal discs revolving in opposite directions either in the horizontal or vertical plane grind the material producing wood flour by abrasion.

The ground material before being graded has to be sorted or classified into mesh size. This is done by "air screening" which is based on the principle that for any given upward velocity there is a rate at which the air resistance of a particle of specific size balances its weight, the larger sizes settling out (2). It is the same principle as operates in the centrifugal action. After classification, the oversize particles are returned to the input side of the grinder. The original practice of mechanical screening, using rotating or oscillating screens of wire of cloth are also still being employed by a number of wood flour mills.

It has been estimated that the investment in machinery required to produce one ton of 40 mesh flour per hour would be between $5,000 and $10,000 (21).

3. *Small dimension stock*—A considerable amount of work has been done in the field of converting slabs, trims, edgings, cull logs, etc., into small dimension stock. Broadly speaking, small dimension stock is lumber usually in small sizes, which is cut from boards, planks, slabs, edgings, trims and logs to different sizes and shapes required by secondary wood using industries in the manufacture of wood articles (15). Small dimension stock generally ranges in size from one-half to six inches thickness by one-half to eight inches in width and in lengths up to eight feet.

In the past, in some instances, saw-mills have undertaken to work up a dimension stock trade as a side line. In most cases, however, dimension stock mills set up independently have worked out more successfully (21). An important consideration in this field as an outlet of waste wood utilization is that associated with economics. Many failures have been reported, but these appear to have been more on account of the lack of adequate merchandizing and manufacturing processes. Dimension stock requires careful handling, closer cutting proper drying which means a small dimension mill must have as high quality of equipment and operator as any lumber mill would have. This, however, does not necessarily mean a very costly equipment and high investment. Craig (10) cites an instance of high capital returns from a small mill investment. This mill equipped with a bolting saw cost only $750. It was powered by a 15 H.P. electric motor and sale returns showed a net profit of $64 per Mbf delivered. This, of course, is an extreme case. Normally small dimension mills have to be equipped to surface, shape and built up panel stock or partially assembled items, if they are to prove renumerative.

Small dimension stock finds a great variety of uses in Industry. Almost any one who uses lumber in its final form in the sizes of the small dimension stock could buy his material as such and at least 50% of lumber, if not more is ultimately used in pieces under 4 inches wide and two feet long. Prof. Hoyle (15) has enumerated over 50 uses of small dimension stock ranging from furniture and automobile parts to coffin and toy articles. There appears no reason why with more knowledge and efficient small dimension milling operations, this outlet of

waste utilization cannot be developed into a profitable business. It is well known that in most of the European countries extensive use is made of small dimension stock.

A grade of hardwood lumber called "Millpack" has recently been recognized by the National Hardwood Lumber Association (21). This material is nothing other than random length and width small dimension stock. The specifications lay down that it be put in bundles of 4, 5, 6 or 8 quarter stock ranging from 3 to 12 inches width and 18 inches and over in length. Each bundle is required to include 40% of the material clean on one face and of this half should be clean on two faces. It is expected that recognition of "Millpack" would substantially add to a more closer utilization of both the low grade hardwood lumber and wood waste.

4. *Wood waste as soil conditioner*—During the recent years interest has considerably developed in the use of wood waste in the form of saw-dust, shavings and chips as a soil mulch and conditioner. New chipping equipment, and more favourable reports on the effect of wood waste on the crops have been mainly responsible (21).

In the past the principal objection to the use of wood on the soil has been that it caused a reduction in crop yield because of nitrogen deficiency. By using the shavings as stock bedding, and then adding lime and super phospate these objections have been overcome. Sixty pounds of ammonium nitrate per ton of wood waste have been found to supply the nitrogen requirements of the crops. When so treated it has been found to have no adverse effect on plant growth, makes a fine mulch, and improves the physical properties of the soil. Contrary to the common belief it does not increase the soil acidity.

Very recently the National Lumber Manufacturer's Association has announced the development of a fertilizer and soil conditioner called "Fersolin" at the laboratory of the Timber Engineering Co. (21). "Fersolin" is derived from saw-dust by heat and chemical treatment and neutralization. The finished product is similar to humus and can be produced quite cheaply. No details have been released yet but the preliminary test indicate a very favourable effect on plant growth.

CONCLUSION

In the foregoing pages have been enumerated some of the outlets into which the waste woods problems have been attempted to be channelled during the past twenty years or more and which hold great potentialities for further development. A lot of research work has been conducted and is still being conducted both at the Forest Products Laboratory and private educational and research organizations. The most economic disposal of wood waste is still a problem of growing concern to all the woodworking industries. The fundamental question in relation to wood waste still is – how to reduce it or use it ? It is true that there is no quick and easy solution of the problem of waste wood utilization, but the opportunities of waste utilization are numerous. It now rests with the individual woodworking industries or saw-mills or groups of industries to explore the possibilities of both reducing and utilizing their waste in a manner most economical and profitable to them.

Shortages of material following World War II have created or increased demands for products that can be recovered from waste so that there are now better markets than those that existed previously. It should, however, be remembered that this technology of close wood utilization is a comparatively young science. It is only recently that pulp, fiber board, plastics and a rapidly growing wood chemical industry have created uses for almost anything that composes a tree. It, therefore, appears more likely that the future development would be more in the sphere of chemical utilization than mechanical utilization.

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A NOTE ON TWO SPECIES OF *TRIUMFETTA* FROM UTTAR PRADESH

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In connection with the revision of his 'Forest Flora for Pilibhit, Oudh, Gorakhpur and Bundelkhand' Mr. P. C. Kanjilal, I.F.S. (Retd.), while recently working in the Dehra Dun Herbarium asked me to investigate a number of nomenclative queries, the result of one of which, relating to the correct nomenclature of the two species of *Triumfetta*, viz., *T. rhomboidea* Jacq. and *T. pilosa* Benth., which are dealt with in his Flora, is embodied in this note.

A search through the literature and works of reference on Indian Botany reveals that the correct name of *T. rhomboidea* Jacq. is *T. bartramia* Linn. In this connection I can do no better than to quote a relevant passage from 'Notes on Jamaica Plants' by William Fawcett and A. B. Rendle which appeared in Journal of Botany 59 : 224–226, 1921.

'LINNAEUS adopted Plumier's genus *Triumfetta* (Gen. Pl. 344 ; 1737), and described both calyx and corolla apparently from Plumier's rough drawing (Nov. Pl. Amer. Gen. t. 8). Later in the same year he described at length (Hort. Cliff. 210), under the same generic name, a plant growing in Clifford's garden, which led him to alter his description (Gen. Pl. ed. 2, 243, 1742) and state that the perianth was single – not with both calyx and corolla. The description in Hort. Cliff. was cited in *Species Plantarum* (444, 1753) for the single species there named, *Triumfetta lappula*'.

'In *Flora Zeylanica* (77, 1748) Linnaeus had already founded a genus *Bartramia* on a plant in Hermann's herbarium (now in Herb. Mus. Brit.) with both calyx and corolla, and on an earlier page of the *Species Plantarum* (389) he gave the plant the specific name *B. indica*. Six years later (Syst. ed. 10, 1044) Linnaeus included *Bartramia* in *Triumfetta* and altered the trivial, naming the species *T. bartramia*. The earliest trivial is, therefore, *indica* ; but as Lamarck subsequently described (Encyc. iii, 420, 1789) a *Triumfetta indica*, the identity of which is doubtful, we have adopted the Linnean name *T. bartramia*. De Candolle (Prodr. i. 508) remarks "*T. bartramia* (Linn. sp. 638) indeterminata manet, cum synonyma omina ad diversas species pertineant", and adopts Jacquin's name *T. rhomboidea* (Enum. 22, 1760). Later botanists followed De Candolle, although there is no difficulty in ascertaining exactly what Linnaeus's species is, namely the plant in Hermann's herbarium. The synonymy cited by Linnaeus depends on figures in Plukenet and Petiver, the determination of which is doubtful, and in any case does not affect the species name'.

The synonymy and references to *T. rhomboidea* Jacq. are thus as follows :—

Triumfetta bartramia, Linn. Syst. ed. 10 (1759), 1044 ; Roxb. Fl. Ind. ii (1832), 463 ; Fawcett *et* Rendle in Journ. Bot. lix, 224 – *T. rhomboidea*, Jacq. Pl. Craib (1760), 22, *nomen, et,* Select. Stirp. Amer. (1763), 147, t. 90 ; DC. Prodr. i, 507 ; Mast. in Hook. f. F.B.I. i, 395 ; Cooke, i, 147 ; *multi alii* – *Bartramia indica*, Linn. Sp. Pl. i (1753) 389 – *T. trilocularis*, Roxb. Fl. Ind. ii (1832) 462 – *T. angulata*, Lam. Encycl. iii, 421.

In the above synonymy the earliest trivial name is '*indica*' but as stated earlier and again pointed out by Craib [Florae Siamensis Enumeratio (1931) 190] it 'cannot be used owing to the incompletely known *T. indica*, Lamk.'

The case of *Triumfetta pilosa* Roth is rather complicated. As an explanation I refer to a passage by V. Narayanaswami in which Craib's Florae Siamensis Enumeratio is reviewed

(Journ. Ind. Bot. Soc. 5 : 33, 1926) 'on page 191 *Triumfetta cana* Masters in F.B.I. p. 396 *non* Bl. is, I think, a mistake ; for *T. cana,* of F.B.I. by Masters is identical with *T. cana,* of Bl. Bij. i, 113. Because Masters' description of the capsular spines being straight ciliated is clearly an error in judgment as is shown on an examination of the sheets he quotes, i.e., Hk. and Th.'s Khasia mountain specimen, which has the spines distinctly bent at the tip. On no sheet of *T. cana,* Bl. (Masters) in the Calcutta herbarium are the spines seen perfectly straight, but all are more or less bent. It is also considered that the change of *T. cana* Mast. to *T. pseudocana* of Sprague and Craib is in the first instance unnecessary, and secondly according to specimens in Calcutta herbarium, *T. cana,* of Masters has been proved to be identical with *T. cana,* Bl. Further *T. cana,* Mast. is in no way distinct from *T. tomentosa* Boj. which is described as having straight transparent bristles but which actually is not so, as a close examination of all the sheets in Calc. Herbarium has shown that the transparent bristle tips in all cases are more or less bent and not straight. Hence instead of multiplying synonyms for one and the same species, it is convenient to have all these reduced to *T. pilosa* which is the earliest authentic name of the species and making *T. tomentosa* and *T. cana,* Mast. and Bl. as varietal forms only'.

I have myself examined the entire collection of *T. tomentosa* Boj. in the Dehra Dun herbarium and I entirely agree with Narayanaswami's views stated above excepting the last sentence wherein he states that *T. pilosa* is the earliest authentic name of the species. As far as I can ascertain from the literature available with me here *T. tomentosa* Noronha is the valid and older, going back to 1790, and that name, therefore, as suggested by Blatter (Journ. Bom. Nat. Hist. Soc. 34 : 890, 1931), must be retained under the rules, as shown below :—

Triumfetta tomentosa, Noronha in Verh. Batav. Gen. v (1790), ed. i, Act. iv. 27 – *T. pilosa,* Roth Nov. Pl. Sp. (1821), 223 ; Wight and Arn. Prodr. i, 74 ; Mast. in Hook f. F.B.I. i, 394 ; Cooke i, 147 ; Gamble Fl. Madras (1915), 120 ; Haines Bot. Bih. and Or. (1921), 85 (*erronee adscripta Roxburghio*) – *T. oblongata,* Link Enum. Pl. Hort. Berol. ii, 5 – *T. cana,* Blume Bijdr. i (1825), 113 ; Mast. in Hook. f. F.B.I. i, 396 – *T. pseudocana,* Sprague and Craib in Kew Bull. (1911), 23 ; Ridley Fl. Malay Pen. i (1922), 304. *T. tomentosa,* Bojer in Ann. Sc. Nat. ser. ii, xx (1843), 103 – *T. tomentosa,* Telfair ex. Wall. Cat. n. 1080.

From the synonymy given above it is clear that *T. pilosa* Roth, *T. cana* Bl., *T. pseudocana* Sprague and Craib and *T. tomentosa* Boj. refer to one and the same plant and should be united and that the earliest valid name for this species is *T. tomentosa** Noronha.

* Incidentally, as pointed out by Fawcett and Rendle (Journ. Bot. 59 : 225–226, 1921), the correct name under the International Code of Botanical Nomenclature of *Corchorus acutangulus* Lamk. Encycl. 2 (1786) 104 is *C. aestuans* Linn. Syst. ed. 10 (1759), 1079 (*non* Forsk.). Similarly the earliest valid name for *Corchorus antichorus* Raeusch. Nom. Bot. ed. 3 (1797), 159 is *C. depressus* (Linn.) Stocks in Proc. Linn. Soc. 1 (1848), 367, as this species is based on *Antichorus depressus* Linn. Mant. (1767), 64.

PLANTATIONS UNDER THE FAMINE RELIEF SCHEME BAHRAICH FOREST DIVISION

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SUMMARY

This note describes the work done in respect of raising plantations of several valuable miscellaneous species of commercial importance in Bhinga and Charda blocks over a total area of 760 acres during 1952 under the Famine Relief Scheme. By giving employment to several thousand famine stricken villagers the scheme afforded them great relief. It briefly comments on the selection of suitable areas, method of soil working, plantation technique adopted, choice of species, method of sowing, nature of fencing and subsequent tending including weeding and protection and also establishing nurseries at several places. A statement showing the details of the expenditure on each item is appended.

General—Owing to prolonged drought on account of complete failure of monsoon during 1950 and 1951 agricultural crops, both *rabi* and *kharif*, failed almost entirely in the year 1951 in the *tarai* areas, particularly of the Bhinga and Charda parganas of the Bahraich district. It was considered essential to afford relief to the famine stricken people suffering from successive agricultural calamities, and the Government was faced with the problem of finding works of utility on which to employ the villagers to earn their bare minimum wages to enable them to buy enough coarse food grains to save them from starvation.

2. The Forest Department, already alive to the necessity of the much overdue and longfelt need of raising extensive plantations of valuable miscellaneous species of industrial importance, availed itself of the opportunity by promptly offering to employ villagers on works involving an expenditure of over a lac of rupees. The Government sanctioned the scheme and the work was started from end of November, 1951. A large number of villagers including women and children turned up at each plantation centre and the forest staff though not normally used to handling more than, say, 20 to 30 labourers at a time, admirably controlled gangs each of 200 to 300 labourers. The daily wages of the labour employed were fixed by the Government in accordance with the instructions contained in the Famine Relief Code at annas ten, eight and six for a man, woman, and child respectively.

3. Test works were carried out to determine whether scarcity conditions really existed in the locality. The response was overwhelming. There was a terrific rush of villagers and, at times, it became difficult for the staff to control the influx of a considerably large number of labourers. It was, therefore, established that acute scarcity conditions did exist. A sum of Rupees fifteen thousand was spent on this work. The Government on the results of the test works decided that the work should be taken up as one of the regular schemes of the plantations and funds to the extent of Rupees one lac were sanctioned. Rupees Fifty thousand were provided in the financial year 1951–52 and fifty thousand in 1952–53. In terms of the man power mobilized and given relief under this scheme the total comes to over two lacs and a half. On an average about 1,500 labourers including women and children were given employment daily from the beginning of December, 1951 to mid-April, 1952 and 300 labourers for 6 months from May to October, 1952.

4. *Selection of Areas for raising Plantations*—The choice was naturally limited as the works to be undertaken had to be confined to the areas nearest to the villages affected by the

acute scarcity. In Bhinga block the selection of suitable areas was easy. Many areas clear-felled under the *taungya* system during the Second World War could not be artificially regenerated as the change in the land tenure system in the country resulted in the *taungya* cultivators abandoning the forest areas in favour of settling permanently in the land owned by the *zamindars*. There was, therefore, a dearth of *taungya* labour and yet it was imperative that these clear-felled areas aggregating to 480 acres, since overgrown with a rank growth of useless bushes, weeds and grass, must be regenerated artificially at any cost. All such areas were taken up for raising plantations under the famine relief scheme.

5. In Charda block, however, the conditions were quite different. Areas containing natural blanks sparsely stocked with useless species of no economic value were selected. The areas selected under the scheme in this block totalled 260 acres.

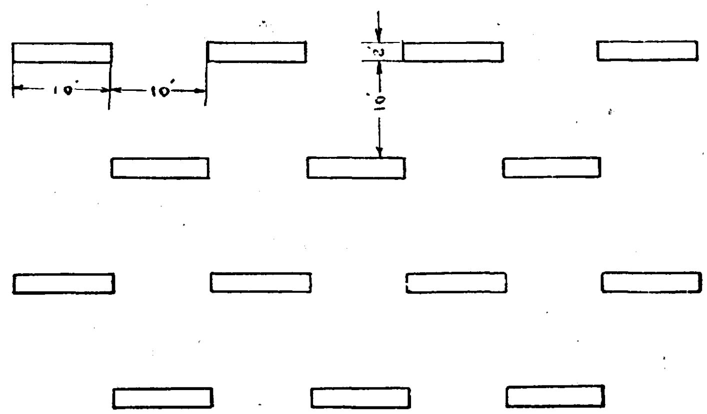
6. The following are the details showing the actual area regenerated in each centre of the two forest blocks :—

Block	Centre	Area (in acres)	Remarks
Bhinga	(*i*) Kakardari ..	112	
	(*ii*) Jabdikot ..	50	This area is a natural blank.
	(*iii*) Shahpur ..	110	
	(*iv*) Sukaiya ..	10	
	(*v*) Gulra ..	108	
	(*vi*) Gandhi ..	140	
	TOTAL ..	530	
Charda	(*i*) Ramnagar ..	164	
	(*ii*) Tulsi Deeh ..	36	
	(*iii*) Bade Deeh ..	30	
	TOTAL ..	230	
	GRAND TOTAL ..	760	

7. *Clearing areas of thorny and other shrubs*—This work had to be completed as a preliminary to aligning the lines for actual soil preparation. It engaged quite a lot of labourers and the control over the actual daily output of each individual was rather difficult as the allotment of the task to each labourer was not quite possible as was in the case of earth work.

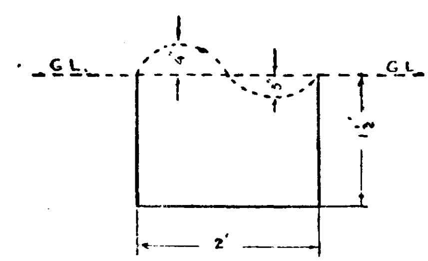
8. *Method of soil working*—Continuous strips spaced 20 feet apart in the clear-felled areas of the Bhinga block and interrupted strips 10 feet long and staggered, spaced 10 feet apart in the rest of the areas containing natural blanks in Charda block and Jabdikot area of the Bhinga block were aligned. The soil working consisted of digging trenches 2 feet wide and 18 inches deep. The earth of the top six-inch layer was put throughout on one side of the trench while the earth of the bottom one foot layer was piled up on the other side of

the trench so that at the time of re-filling the trenches the more fertile top six-inch layer earth got its original place to give the maximum advantage to the seed for germination and the tiny seedling for the development in its early days of infancy. The following shows the actual lay-out of the staggered strips :—



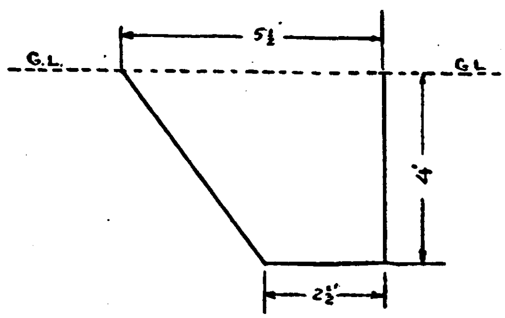
9. The earth work on digging the trenches was controlled by the staff admirably. This item of work was liked by the villagers immensely. The Famine Relief Code prescribes daily task for each adult and child. As soon as one finished the daily task, the work supervisor measured and recorded the work and the labourer was free to get back to home. The total man power strength employed on this work was 72,346. The daily task allotted to each adult male according to the Famine Relief Code was about 60 cubic feet of earth work. This worked out to Rs. 10 per 1,000 cubic feet which is quite a satisfactory result.

10. The soil was allowed to aerate in the sun up to the end of April, 1952. In the first fortnight of May, 1952 the trenches were filled back with earth as detailed above under paragraph 8. The filling of the ditch with the dug up earth was done in such a way that half the width of the ditch from the ground level was raised to a height of about 6 inches and the next half was kept just up to the ground level. After the first heavy shower of rain, therefore, ridges and ditches were conspicuous all over the area. This ridge and ditch method was adopted to ensure successful germination of seed and development of seedlings on ridges in case of excessive rains and on ditches in case of deficient rainfall. The cross-section of the ridge and the ditch was :—



11. *Fencing*—Quite apart from the fact that barbed-wire fencing was not quite feasible due to non-availability of barbed-wire the requirement of which was colossal indeed, it was not intended to spend any funds allotted for relieving the distress of the famine sticken villagers on the purchase of any material. It was decided to have game-proof ditches all round the

plantation areas in all the centres both in the Bhinga and Charda blocks. The size of the cross-section of the ditch was 5½ feet on the top and 2½ feet at the bottom, the depth being 4 feet along the inner vertical side as illustrated below :—



12. All the dug up earth was piled on the innerside of the ditch, i.e., towards the side of the plantation area. Here again the earth work was quite attractive as all sorts of labour, i.e., men, women and children were employed on it. The men were diggers and the women and children were the lifters and carriers of the earth. Almost all the members of a family were thus engaged usefully to their advantage on this work. A man power of over 25,000 was in all employed on this item of work. An adult's allotted task was about 50 c. ft. of earth work which works out to about Rs. 12/8/- per 1,000 c. ft.

13. A thick sowing of *babul* seed was done by broadcasting over the piled up earth in the first week of June, 1952. It was intended to have a dense live hedge of *babul* all round the plantation area between the ditch and the plantations. During the course of the clearing of the areas of the thorny bushes referred to above under paragraph 7 the cut thorny material was dragged to the outerside of the game-proof ditch and arranged all round the plantation area along the ditch. This was done before the digging of the ditch was started. This formed the first line of the defence and the ditch served as the second line of defence in the first year of the plantation. From the second year the live hedge of *babul* is the third line of defence. As a matter of fact, in the second year the first line of defence, i.e., the dead thorny material will perish and offer no resistance to the animals while the ditch may get silted up at places and may become ineffective in keeping away the animals. It will be this dense live hedge of *babul* which will be the real line of defence. The trick to make the *babul* hedge really effective is to keep on trimming the plants from time to time and not allowing them to grow taller then 6 or 7 feet.

14. *Choice of species*—The following plywood, bobbin wood, matchwood, furniture wood and fruit-cum-timber species were sown.

(*i*)	*Semal* ..	*Salmalia malabaricum.*
(*ii*)	*Bhurkul* ..	*Hymenodictyon excelsum.*
(*iii*)	*Tun* ..	*Cedrela toona.*
(*iv*)	*Shisham* ..	*Dalbergia sissoo.*
(*v*)	*Safed siris* ..	*Albizzia procera.*
(*vi*)	*Arru* ..	*Ailanthus excelsa.*
(*vii*)	*Bijai sal* ..	*Pterocarpus marsupium.*
(*viii*)	*Gutel* ..	*Trewia nudiflora.*
(*ix*)	*Jamun* ..	*Eugenia jambolana* (both large and small seeded).

(*x*)	*Am*	..	*Mangifera indica.*
(*xi*)	*Mahuwa*	..	*Madhuca latifolia.*
(*xii*)	*Bahera*	..	*Terminalia belerica.*
(*xiii*)	*Asna*	..	*Terminalia tomentosa.*
(*xiv*)	Chikrassi	..	*Chickrassia tabularis.*
(*xv*)	——	..	*Acrocarpus fraxinifolius.*

The seed of almost all the species was collected locally except that of *Ailanthus excelsa*, *Bijai sal*, *Acrocarpus fraxinifolius*, *Chickrassia tabularis* and *Heterophragma adenophyllum.*

15. *Plantation Technique*—Before sowing the seed the total area in each plantation centre was divided into half acre plots with the object of raising the plantations of different species as a mixture in blocks instead of an intimate mixture of several species all over the area. Only two species were sown intimately in one block. The selection of such two species for sowing as an intimate mixture in one block was based, as far as possible, on the similarity of the silvicultural characters and requirement of the species. The grouping of species for each block was done as detailed below :—

A = *Salmalia malabaricum* and *Hymenodictyon excelsum.*
B = *Dalbergia sissoo* and *Cedrela toona.*
C = *Albizzia procera* and *Madhuca latifolia.*
D = *Pterocarpus marsupium* and *Ailanthus excelsa.*
E = *Mangifera indica* and *Chickrassia tabularis* or *Terminalia belerica.*
F = *Trewia nudiflora* and *Terminalia tomentosa.*
G = *Eugenia jambolana* and *Acrocarpus fraxinifolius.*

16. The sowings were done in the blocks arranged in the Latin Square pattern as below :—

A	B	C	D	E	F	G
B	C	D	E	F	G	A
C	D	E	F	G	A	B
D	E	F	G	A	B	C
E	F	G	A	B	C	D
F	G	A	B	C	D	E
G	A	B	C	D	E	F

17. The sequence had, of course, to be modified to suit the local requirement of the soil, chiefly, in respect of water-logged conditions which were, however, of a temporary duration. One single line of seed was sown over the central part of each of the ridge and ditch, and on either side of the two lines *khair* seed was sprinkled. *Khair* was sown as a protective species against browsing by wild animals. The main sowing work started from the 12th of

June, 1952 and the first shower of the monsoon fell on June 21, 1952 when about the two-thirds of the total area had been sown. Sowings were completed by about the 10th of July, 1952 in all the centres.

18. The monsoon was unfortunately unfavourable all through the season. The first nine days from June 21 to 29, 1952 after the break of the monsoon had unusually excessive rain aggregating to about 17 inches resulting in the flooding of the low lying areas and silting of the seed lines. Consequently a large scale re-sowing had to be resorted to. The gaps were planted with nursery stock of pruned transplants and stumps of *semal, bhurkul,* and *tun*. Selfgrown seedlings of *jamun* from the nearest shady localities were collected and planted in the lowlying areas in which seed had perished due to excess of water. July was rainless. This gave a blow both to the seedlings produced from direct sowings and to the entire transplants and stumps. A third attempt regarding filling up the blanks with entire planting was made in August, 1952 after a few showers of rain in the first week of the month. In an attempt to stock the entire plantation area, the beating up of the blanks was done in August, 1952 with any available nursery stock irrespective of the species originally allotted to a block. This, no doubt, interfered with the original block mixture scheme but did not, certainly, upset it altogether. In August the rainfall was fairly satisfactory and just enough to keep the plants alive. The months of September, October, November and December had no rain, whatsoever. Drought mortality, though in a small measure, was noticeable in lines of plants on the raised and high ground in Charda block.

19. *Tending operations*—The first tending operations started virtually with the germination of the seed. This consisted of the spacing out of the seedlings to relieve congestion and pulling out of the weeds by hand without the use of the *khurpi* followed by two weedings in August and September–October, 1952. In both the weedings deep soil working round the plants with *khurpies* gave wonderfully excellent results.

20. The villagers again in despair owing to failure of the rains, turned up in sufficient numbers for carrying out the weeding operations in the plantations and nurseries. In terms of man power the total strength engaged on these operations was over 12,000.

21. *Damage by wild animals*—The game-proof ditch proved effective against domestic and wild cattle, pigs and percupines. Blue bulls and *cheetal* (spotted deer), however, jumped over the ditches and proved a great nuisance at one time particularly in the month of September 1952. *Gutel* was browsed badly by blue bulls. The outer fence consisting of dead thorny bushes was re-inforced in the month of October and November, 1952 to eliminate blue bulls and *cheetal*. It is very gratifying to note that the percupine damage was almost absent. Plantation watchers to scare away blue bulls and *cheetal* particularly during the night were engaged throughout the rains in all the centres.

22. *Results obtained*—*Babul* seed sown in the piled up earth along the game-proof ditch germinated profusely. Despite the unfavourable monsoon the average height of the *babul* plants over many stretches was five feet in January, 1953. In poor soil the growth was not so satisfactory and at places which were few in number re-sowing may have to be done next June. On the whole the results are very satisfactory indeed.

23. In respect of the results of the sowing and planting in the plantation areas it can safely be remarked that the efforts have, despite the deficient and erratic rains, proved very fruitful indeed. In the areas clear-felled in the past for artificial regeneration under the *taungya* system referred to under paragraph 4, the results may be classed as excellent. In the rest of the areas which contained natural blanks and were without any vegetation the results may be classed as moderate. On the whole both the survival per cent and height

growth are very satisfactory. In the Ramnagar plantation centre in Charda block casualties due to drought in October and frost in December, 1952 were noticeable but the damage is not significant.

24. The height growth of some of the well grown plants in the plantations considered as excellent was measured in January, 1953. The measurements show :—

Species	Average height	Height of best plants
	feet	*feet*
1. *Salmalia malabaricum*	2	4
2. *Ailanthus excelsa*	4	5½
3. *Albizzia procera*	4	5½
4. *Dalbergia sissoo*	3	5½
5. *Madhuca latifolia*	8″	1
6. *Mangifera indica*	14″	1½
7. *Cedrela toona*	2	4
8. *Trewia nudiflora*	3	4
9. *Acacia catechu*	3	5
10. *Eugenia jambolana*	1	2

25. The rain on January 15 and 16, 1953 came as a great boon to the plantations and nurseries. This rain will, it is hoped, carry the plants through a greater part of the coming summer. Provided the coming hot weather casualties are not appreciably significant no filling up of blanks is envisaged at this stage except in a few gaps in Charda block.

26. *Cost of raising the plantations*—The total expenditure incurred up to the end of December, 1952 on raising the plantations over 760 acres was Rs. 1,17,200 and on establishing nurseries aggregating to about 10 acres at 15 different centres was Rs. 10,000. In addition an expenditure of Rs. 4,800 was incurred on the construction of new wells and renovation of 6 old wells near the nursery sites. The total expenditure incurred is detailed centrewise for each item of work in the statement appended with this note. It may be summarised as follows :—

	Rs.
1. On raising plantations over 760 acres	1,17,200
2. On establishing nurseries at different centre	10,000
3. On digging new and renovation of old wells	4,800
TOTAL ..	1,32,000

27. The plantations raised under the Famine Relief Scheme had to be nursed up and tended with the ordinary forest funds after spending all funds sanctioned under the Famine Relief Scheme. The total expenditure on raising plantations over 760 acres is Rs. 1,17,200 and this works out to Rs. 154 per acre.

Statement showing the details of expenditure on raising plantations over 760 acres and 15 nurseries at different centres under the Famine Relief Scheme 1952

Serial No.	Items of work	Block		Total	Cost per acre (approximate)
		Bhinga	Charda		
		Rs.	Rs.	Rs.	Rs.
1	Shurb cutting and digging of stumps	3,600	12,000	15,600	21
2	Digging of game-proof ditches ..	6,500	3,200	9,700	13
3	Digging trenches for the plantation lines	25,800	13,400	39,200	51
4	Filling the trenches (item 3) with earth	10,000	4,100	14,100	19
5	Sowing and planting including beating up of the casualties ..	2,400	1,600	4,000	5
6	Weeding	6,000	2,400	8,400	11
7	Seed collection	2,500	2,000	4,500	6
8	Miscellaneous such as *Dagbelling*, construction of motor roads ..	5,600	3,000	8,600	11
9	Supervisory staff employed on daily labour wages	4,300	4,000	8,300	11
10	Purchase of articles	600	1,200	1,800	2
11	Reinforcing the dead thorny fence	2,000	1,000	3,000	4
	TOTAL ..	69,300	47,900	1,17,200	154

Nurseries

		Rs.	Rs.	Rs.
1	Soil working, laying out of beds manuring, fencing, seed sowing and subsequent tending including weeding and watering	7,000	3,000	10,000
2	Digging of new wells and renovation of old wells	2,400	2,400	4,800
	TOTAL ..	9,400	5,400	14,800
	GRAND TOTAL ..	1,17,200	14,800	1,32,000

NEW COMPLICATIONS IN THE NAMING OF PLANT SPECIES

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There is a widespread and legitimate dissatisfaction among professional botanists and others interested in the study of plants that plant names, both generic and specific, change much too often. It is rather disheartening to find that the old familiar names by which a particular plant may have been known from years is suddenly shifted to another genus or within the genus changes the specific name. This dissatisfaction has given rise to the demand from some quarters that an International Botanical Congress issue a list of *Nomina specifica conservanda* similar to the one already in existence for generic names. Up to the present all International Botanical Congresses have refused to accede to this petition, and in the opinion of the present writer justly so; such a step would interfere with the free progress of botanical science, as has already been pointed out by him in the Journal of Scientific and Industrial Research 10 : 49–50, 1951.

In the new International Code of Botanical Nomenclature issued by the Seventh International Botanical Congress, Stockholm, 1950, there has appeared a new rule that in the opinion of the present writer is bound to create much confusion. I am referring to paragraph 3 of Article 42 of the new Code, that reads as follows: "*No combination is validly published unless the author definitely indicates that the epithet or epithets concerned are to be combined with the generic name in a particular way*". By way of explanation the compilers of the Code add a few paragraphs, from which the following are taken:

> "Examples of combinations definitely indicated: In Linnaeus' *Species plantarum* the placing of the epithet in the margins opposite the name of the genus clearly indicates the combination intended. The same result is attained in Miller's *Gardeners Dictionary*, ed. 8, by the inclusion of the epithet in parentheses immediately after the name of the genus. .... Examples of combinations not definitely indicated: .... The combination *Eulophus peucedanoides* must not be ascribed to Bentham and Hooker f. on the basis of the listing of *Cnidium peucedanoides* H.B.K. under *Eulophus* in the *Genera plantarum*".

Unfortunately the practice followed up to the present, or at any rate, up to the publication of the new International Code is to ascribe the combination to an author, like Bentham and Hooker f. when the author definitely states that the particular plant known previously under a given name should be placed under a new genus. If an author clearly states this to be his intention, and names the species of the previous genus to be transferred, it seems to be sufficiently clear that the author makes the new combination.

In this respect there is a double practice among authors, and their standing in view of the new Article is not or ought not to be, the same. In Hooker f. *Flora of British India*, (1 : 62–67), a number of species of *Polyalthia* are ascribed to Benth. and Hook. f. on the strength of a doubtful reference to *Genera plantarum*; in the latter book (1 : 25) these authors write: "Species genuinae biovulatae 5, in Asia tropica crescentes. .... His tamen addendae, etsi in sectionem alteram colligendae, *Guatteriae* gerontogeae fere 25, quarum una Australasica, ceterae Asiaticae. .... ". Here the species to be transferred are not named, the authors merely indicate that nearly 25 species of *Guatteria* are to be placed under *Polyalthia*; they have not made the combination, nor have they stated which species of *Guatteria* ought to be transferred; it would seem that *all* the species of *Guatteria* known in their time ought to go to the

genus *Polyalthia*. This type of transferring a species from one genus to another may leave subsequent authors in some doubt as to the exact species concerned.

On the other hand, the same authors in *Genera plantarum* 1 : 885, under *Eulophus*, write: "Species 3, una Arkansana....altera Andium Americae australis tropicae. et Mexici incola (*Smyrnium lineare*, Benth. Pl. Hartw. 83 ; *Cnidium peucedanoides*, H.B. et K. Nov. Gen. et Sp. v, 15) utraque foliorum segmentis linearibus, tertia Texana (*Tauschia texana*, A. Gray, Pl. Lindh. in Bost. Journ. Nat. Hist. vi, 211), humilior, foliorum segmentis cuneatis incisis et involucellis insignis. .... ".

Robert Brown in his paper on the Asclepiadaceae and Apocynaceae in Mem. Wern. Soc. 1 : 12–78, 1809–11, speaking of his new genus *Gymnema* lists four species that he wishes to place in the new genus ; he does not make the combination in the sense that typographically he joins the new genus with the old specific name, he merely states that a given plant belongs to the new genus. On p. 33 he writes : "Of this genus (i.e., *Gymnema*) I have examined four species. Two of these are unpublished plants ; the third is *Asclepias lactifera* Linn. ...... The fourth is *Periploca sylvestris* Willd. sp. pl. 1, p. 1252". And again under *Parsonsia* on page 65 he writes : "The American species of this genus, viz., *Echites corymbosa* Jacq. *floribunda* Sw. and *spicata* Jacq. differ considerably from the rest....Among these the only published species is *Periploca capsularis* Forst. prod. n. 126. .... ". At least in the species actually named by Brown, there is no possibility of doubt that he intended them to be transferred to the new genera created by him.

I have cited Benth. and Hook. f. under *Eulophus* and Robert Brown because this method of making transfers from one genus to another seems to be far from rare in botanical literature ; if the species are nominally listed, this should be considered a sufficient indication that the transfers are clearly made, at least as far as the past goes. The two types of listing transfers from older genera are not quite the same, since the second method names the plants to be transferred and clearly states that they belong to the new genus ; the former type merely states that a certain number of a given genus ought to go to the new genus.

According to the new regulation now being introduced by Art. 42 of the International Code, many of the old familiar authorities for the names of plants in India and elsewhere will have to be changed, and this will entail an undue amount of research into the literature in order to find out the name of the person who first made the combination *typographically*. It is bad enough to have the specific names changing so often ; from now on we shall have an endless number of changes in the authorities for the various names. This is sure to result in even greater dissatisfaction among botanists than merely by changing the specific epithets, or rather the two sets of changes may produce a sort of despair among Indian botanists, who may not have access to the relevant literature on the subject.

After much consideration on this point, I venture to make a suggestion for the consideration of the next International Botanical Congress that is due to assemble in Paris in the near future. Article 44 of the new Code states that "on and from 1 January 1935, names of new taxa of recent plants....are considered as validly published only when they are accompanied by a Latin diagnosis". Similarly Article 45 states : "On and from 1 January 1912, names of new taxa of fossil plants .... ". And Article 41 : "On and after 1 January 1953, the distribution of an exsiccatum .... ". In other words, such regulations, in the mind of their makers, did not have retroactive effect, but came into force only for names published after a given date ; names published in the past contrary to such regulations are to be considered as validly published if they conform with the regulations in force at the time they were published ; future names, however, will have to conform to the new regulations.

In order to save much trouble for a number of years to come, I would suggest the following amendments to the new regulation under paragraph 3 of Article 42 : (*a*) Names published by mentioning the older species to be transferred to a new genus, should be considered valid ; such is the case with *Eulophous peucedanoides* of Bentham and Hooker f., or with *Gymnema sylvestris* of R. Brown. (*b*) Names published in the same method as *Polyalthia* of the *Genera plantarum*, where the older names have not been mentioned, to be considered as not validly published at all. (*c*) On and after a certain date to be fixed by the next Botanical Congress, only combinations actually made, i.e., *typographically* expressed, to be considered as valid for the future without retroactive effect.

If the present new rule is allowed to remain as it stands in the new Code, then one only has to wish good luck and patience to the compilers of *Index Kewensis* and to wish them all speed in the publication of subsequent supplements of this monumental work. Meanwhile for years to come we shall remain in the dark about the real authorities for the names of our Indian plants and those of us, like the present writer, who are working in plant taxonomy will have either to wait for long or to publish their papers with the depressing uncertainty that many of their names are ascribed to the wrong authors.

FOREST REMINISCENCE ; MOSTLY ABOUT SNAKES

BY E. K. KRISHNAN

District Forest Officer (Retd.), Madras State

Forest settlement work is generally an uninteresting job, particularly so if the forest selected for reservation is of the dry deciduous scrub jungle type met with in Districts like Salem. It is, however, a part of the forest officers duty to be thoroughly conversant with the method and procedure of settlement and so it was that I found myself summoned, whilst I was a probationer in the Forest Department, some 40 years ago, to join the District Forest Officer, Mr. L. in camp to do the practical work prior to reservation of Hudaidurgam block of about 20,000 acres in the remote corner of the District. This block is surrounded on all sides by cultivation and villages and consequently the claims for rights of way and enclosures were many.

It was a novel experience for a new recruit to the Department to stay out in tents for 2 or 3 weeks at a time and I thoroughly enjoyed the camp life it involved. We were a large party – the District Forest Officer and his staff of camp clerks and servants, the Sub-Collector and his party of Revenue Officers like Thasildar and Karnams, Village Officers by the score bringing supplies of milk, *ghee* and chicken for the *Sahibs*; all these made the camp hum with life and excitement. What was erstwhile a remote unknown camp suddenly sprang to life and it was great fun listening to complaints and arguments in favour of some concession to be granted regarding lands to be excluded from reservation or some temple or footpath to be demarcated for communal benefit.

Our daily programme was to do four to six hours of out-door work and two hours of office work. This left the evening free and it was great fun exploring interior parts of the block with just a gun and a dog for company. For a gun I had a 12 bore Westley Richards and a ·22 bore BSA rifle to choose from. For a dog my white Rajapaliam hound "Rani" was my constant companion. Many a day have we two climbed a lone steep hill and chased wood cutters away from their evil practice. Tho' not a good gun dog like the terrier "Jimmy" I had, she had had a good training with other *shikar* dogs and would put up jungle fowls and partridges admirably. She was a most affectionate creature and stood some 2 feet 11 inches high and was a good watch dog too. Once we lost our way in deep jungle and not knowing which way to proceed I left the dog to decide by instinct the nearest way to habitation and sure enough the bitch took a bee-line to the nearest village inside the forest, from where we secured a guide who took us to the camp at midnight, much to the relief of the servants and peons who were wondering what had happened to us.

On another occasion we had a miraculous escape from the fangs of a reptile. This time the *chokra* and gun boy "Thimmen" was with us, carrying the 12 bore, and I had the ·22 rifle slung on my shoulder. I was after some imperial pigeons high up on a Eugenia tree and had gone on ahead of the *chokra* who was holding "Rani" lest she should disturb the birds. I was peering thro' the branches to take a pot shot at the birds when some instinct compelled me to look down and lo' within 9 inches of my toe was the head of a Python. That was all I could see, for the rest of the body, as I discovered later, lay covered up and hidden in leaves. The first impulse was to jump back, which I did with the agility of an Ibex, quite a yard behind and ~~got~~ entangled in a thorny Randia bush which tore a 3 inches strip off my breeches. I shouted for my 12 bore but before it arrived I saw the head of the Python slowly receding. I was not sure what the next move on the part of the snake might be, so I plucked up courage and aiming at the head put a bullet between the eyes at the close range of a yard. The head

was shattered but the reptile in its agony wriggled itself loose from the covering of leaves, lashing its tail in fury, revealed its full length which was quite 10 feet or more. By this time the gun boy had arrived and with the stick he had in his hand broke its back and ultimately killed it. We found on close inspection that it was in young and one or two eggs smashed by the blow revealed wriggling young ones in embryo stage. We could not, between the two of us, carry the reptile to the camp, so the gun boy was sent to the nearest village for help and it took four men to carry the snake to camp where it was promptly skinned and a lady's hand bag made out of the tanned skin is still a cherished prize out of that day's adventure.

Whilst on the subject of snakes, I must recount another episode more thrilling than the one I have narrated. This happened later in my career in Cuddapah district. I was engaged in surveying the boundary of a reserved forest with a party of subordinates and had reached a cairn which we were dismantling. The watchman was lifting a big stone at the ground level and I was looking on when suddenly a snake, which at a momentary glance appeared to be a young cobra, stung him near the toe. After a yell of fear and pain, the watchman fell down all in a heap on the ground holding his legs which showed 2 distinct punctures. At the moment, our attention being concentrated all on the watchman, it did not occur to us to trace the snake and to see if it was venomous. We saw it disappear into the forest and the colour and marking on the head gave us the feeling that it was a cobra. I, however, set to work to tie up two ligatures one on the ankle and the other higher up below the knee and taking the Brunton lancet, which I invariably carry in my map case or bag, opened up the punctures by a slit and rubbed permanganate of potash into it. By this time the watchman had collapsed into a daze and he was carried pick-a-back to the nearest village where he was given first-aid in the shape of hot drinks and massage. At the suggestion of villagers and at his own insistence, it was decided he should be removed to a temple (koil) in a neighbouring village reputed to be the house of a famous snake charmer. This was eight miles away and my car was placed at his disposal and the watchman, still in a daze, was taken before the deity and offering made and *puja* conducted in all solemnity. Strange to say the man, who was hitherto in a daze suddenly picked up courage and strength to come back smiling to the car and so was brought back to home none the worse for the mishap except for a wound which healed in about a fortnight. Perhaps my surgery was effective ; the villagers swear by the potency of the charm administered by the *pujari* ; for all we know the dose of venom injected by the snake was not sufficiently lethal.

It was in one of the camps near a village that I first got a chance to get acquainted with the technique of trapping a Panther. One fine morning we were roused in our tents, with the noise of a tom-tom and trumpets and on peeping thro' the doorway were surprised to see quite a score of village folk, men, women and children, wheeling a country cart whereon was placed a wooden cage containing a live panther looking so pathetically remorseful. Behind the cart came a gaily garlanded goat with painted horns and saffron smeared body. On enquiry as to what the significance of this strange procession was, it was elicited that the wary panther had for once in his life paid the penalty for letting his greed and hunger overpower his natural instinct to give a wide berth to any contraption in the nature of a trap. The procession went from door to door of the tents and collected what *bakshis* it could collect from the *sahibs* and later wended its way to the neighbouring village collecting crowd and money wherever it went.

Surprised at the fate that had befallen so wary a creature as a panther at the hands of the villagers, we decided to see for ourselves how the trap worked. Being an off duty day, we called the local *shikari* and armed with our fowling pieces proceeded to the locality where the trap, locally known as *pulibone*, was constructed. On our way "Rani" put up a brace of partridges, which fell to a right and left of the District Forest Officer's gun ; later two hares bounced past but were too quick for our guns. I was surprised to see a snipe flushed from a bush, one of which, a painted wood-cock variety, fell to the gun of the Sub-Collector Mr. A.

The varieties of butterflies met with along stream beds were numerous. The District Forest Officer Mr. L. was a keen Collector and it was his habit to carry a butterfly net on his hat and he would dash off after a rare *Papilio,* often in the midst of serious discussion and having got it place it in his cyanide jar for further treatment and study.

It was during this march that I first got acquainted with that most elusive of birds, the black partridge. We first heard the familiar cry which EHA (or is it Whistler ?) mimics as being *Subban there Khudrath*. I was aware of the habit of this bird to perch on the tallest tree and utter its familiar cry and how on the approach of men would drop down from the tree to run and hide in the nearest bush until flushed again by men. I was asked to locate the bird. I thought I heard the cry from a tree in front of me. On approaching it cautiously, the bird, evidently spotting the intruder, stopped calling. Sometime later I thought I heard the call again, this time from a tree further south. It stopped when I moved. So the game proceeded until I gave up the search in sheer desperation. The bird was a veritable ventriloquist and it was a problem locating it. So I called a couple of men to beat the forest for me. The bird was flushed from a tree different altogether from the one I had expected. Even so it gave me an easy shot but imagine my chagrin and disappointment when I discovered that I had fired a bullet from my left barrel in my excitement and naturally missed the easy shot. I was to see this bird at closer range from C.L. Bhavi camp in Cuddapah district where I laid a wager with my son, who was spending his college vacation with me, that he wouldn't shoot the bird sooner than I could. He got busy and brought me a dead bird within a couple of days and naturally won the bet.

This is, however, a digression. We took quite an hour reaching the hillock where the trap had been set and saw it was a crude contraption built of loose boulders in the shape of a cage, some 8 feet long, walled off into two compartments open at either end. In one of this the goat has been imprisoned, the other had an opening, big enough to admit a panther which could be closed with a slab poised above it and supported by struts. The struts are so placed that any animal entering the cage would foul them to bring down the slab which would either break its back or imprison the animal by blocking the exit. By the recent capture the boulders had been displaced and the villagers had already set about repairing the damage done to it. Of the fate of that unfortunate panther, little said the better. Its mutilated skin still hangs on the wall of the village rest-house.

GUARDIANS OF THE KARRI FORESTS*

BY T. A. G. HUNGERFORD

Photographs by J. Gallagher and C. Bottomley

In the South-western corner of Australia there are vast tracts of forest which contain millions of super feet of karris, one of the best hardwoods known – an asset of inestimable value in a world of shrinking timber resources. The most modern and comprehensive precautions are taken to ensure a sustained yield and protect them from the most savage enemy, the forest fire.

In 1950, the Divisional Forest Officer told us, you could hear the fires six miles away ; the thunderous crash of the burning giants and the terrifying roar and crackle of the conflagration as it leapt from tree to tree on a fierce wind created by the very intensity of its own flames. That black year of rainless months, long hot days and tinder-dry undergrowth, he said, cost Western Australia thousands of acres of irreplaceable timber.

It was hard to realize, sitting in his office at the Divisional Headquarters, just outside the timber town of Pemberton. There had been no serious outbreak of fire in the karri country since then and the bush is quick to regenerate. Through the windows we looked out on the massed twinkling leaves of an army of trees, great and small, that pressed close about this small clearing. We had travelled for miles over gravelly roads and rough bush tracks flanked by magnificent veterans that were old long before Australia was discovered. Everywhere a vigorous regrowth of saplings sheltered beneath the spreading umbrella of the towering giants.

The colossal destruction of 1950 was a long way away, but nobody knows better than the Divisional Officer that at the drop of a hat – or perhaps, of a carelessly discarded cigarette end – it could come again. Every day and all day his work and thought is to prevent it.

He is one of 16 of his class in the State, a graduate of the Australian School of Forestry at Canberra. To obtain his degree of Bachelor of Science in Forestry, he studied for four years – two at a State University and two at the School in Canberra. In that time, he completed 52 weeks of practical field work, inclusive of 12 weeks while at the State University.

In the unit of fire fighters, the Divisional Forestry Officer approximates the G.O. of a battalion and his responsibility is the administration of the Pemberton district of four sub-districts, or out-stations, each 200 square miles. Each of these in turn is controlled by a Field Officer, the N.C.O. of the force, who is recruited from among the best of the timber workers. With an overseer and a gang of six men – "the lance-corporal and party of six" to whom, in the Army every job comes in time – he attends to a wide variety of forestry chores – development, suppression and control of fires, control burning and maintenance of telephone line, roads and bridges.

It is not easy to estimate accurately the age of a karri tree, as the annual rings, a tally of which is the most commonly accepted method of judging a tree's age, are very close together and sometimes inseparable. In any case, the tree might add more than one ring in a good season and less than a ring a year as it reaches age. Calculation by measurement of yearly girth expansion also is misleading, as a young tree might add as much as $1\frac{1}{2}$ inches each year while the veterans rarely put on more than $\frac{1}{4}$ inch.

* Published with the compliments of the Australian High Commissioner, India.

The karri is said to be at its prime at 300 or 400 years. From then on it suffers a gradual loss of annual increment until, at the age of 1,000 years, it is – understandably enough – senile, moribund and riddled with disease. The trees now being cut in the Pemberton forests range from 300 to 800 years of age and it is the responsibility of the forestry staff to see that the right ones are felled.

The Forestry Department of Western Australia has marshalled its forces to ensure a sustained yield; which means that this enormous capital of trees will be mulct each year only of the interest which it earns – the annual regrowth. In this way, by working on a 30-year cutting cycle, it is hoped that these forests, unlike so many that were burned and blasted and hacked into oblivion in the first unbridled assaults of the dawning timber age, will never be lost to Australia.

Before the timber getters are allowed into any tract of the karri country, it is carefully examined by foresters who mark the bases of selected trees with the brand of the Forestry Department. They also indicate, for minimum destruction of sapling growth and ease of access, the direction in which the tree is to be felled.

The trees marked for export or use as railway sleepers inside Australia – the karri is unsurpassed for this purpose, being extremely durable as well as unpalatable to the voracious white ant – must pass rigid specifications.

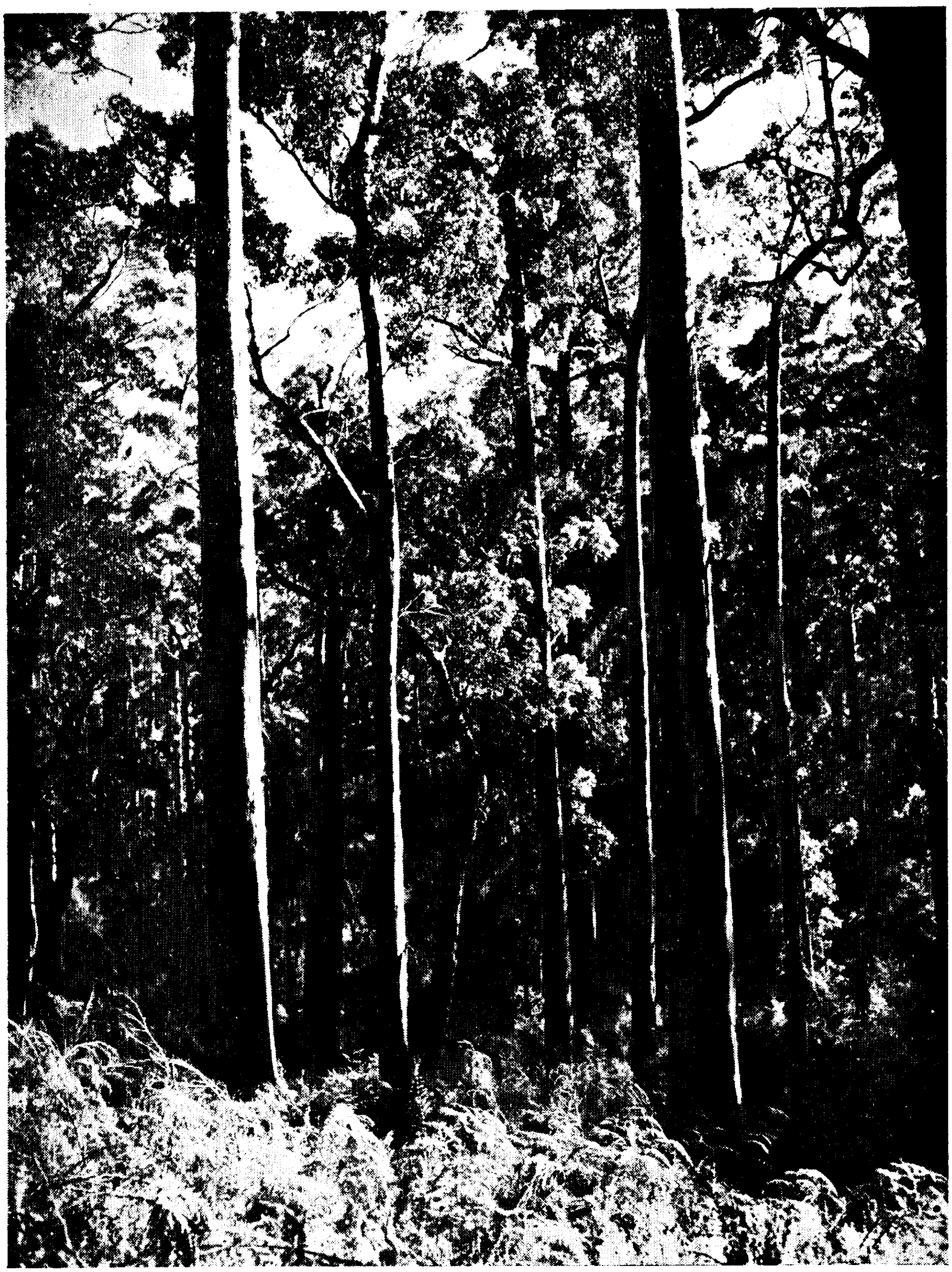
All the preliminary work of the foresters is not apparent to the casual witness to the end of a career which, however static, might have lasted for half a thousand years. Two muscular midgets labouring at the base of a mighty stem have no connection with the statistics of the Divisional Officer; sunlight that makes the swung axe a glittering arc of light, the blood-red scarf in the pale, mottled bark and the sharp scent of acetic acid from the bleeding tree; bush smells and bird calls and the impatient growling of unseen tractors dragging away the carcases of previous victims have nothing to do with the dry calculation of quality and super feet. But wherever he works the axeman feels the breath of the forester on his neck – his identification number is stamped on the butt of every tree he fells and any infringement of the requirements laid down by the Department brings swift retribution.

Reafforestation does not have to be practised in the karri country. Every three to five years the "karri flow", a tremendous cascade of the karri's creamy blossom, revitalises the forests. It is a natural cycle upon which the seasons have no effect.

There are approximately 17,000 karri seeds to the ounce, of which perhaps only a fraction of one per cent germinates. The proportion depends upon the weather; the species of tree and its location in the forest. Under ideal conditions about 10,000 seedling karris jostle into one acre of bush, but 20 years later only 800 of them survive. The passage of another 60 years finds no more than 120 left, and of those only 40 are in the top class – of the rest some are dead or dying, some completely dominated by their more vigorous neighbours and destined for oblivion. There is no planned thinning out; it is the natural law of the survival of the fittest.

The forester's contribution is confined to the creation of conditions as favourable as possible to the young trees. This is the job of the out-station gang. As soon as an area has been cut out they move in and begin top disposal cleaning, the burning off of the lopped leafy crowns of the fallen trees. They remove the tops and any other logging debris from around the bases of the sound immature trees and, on a dull day of no wind, burn them.

Top disposal serves a three-fold purpose. It removes under the safest possible conditions rubbish that in summer would become a fire hazard; it frees the baby trees from strangling



A stand of mature and immature karri stems in the Pemberton district. The darker trunks among them are of marri, a comparatively useless timber.

Australian Official Photograph by J. Gallagher.

Smouldering ground, bare trunks and the drift of acrid smoke – the tragic aftermath of a bush fire in the karri country.

Australian Official Photograph by C. Bottomley.

A demonstration in the use of heavy duty pumping unit on a karri tree. The four-wheel drive truck carries a 600 gallon tank which under normal conditions lasts for 20 minutes. However, the Hale pump with which it is equipped, and which can deliver a 90 feet vertical spray, is capable of spraying 120 gallons a minute.

Australian Official Photograph by J. Gallagher.

A tower-man ascending the 200 feet lookout on the Gloucester Tree, tallest of five in the Pemberton district. When the tree's crown is lopped, it throws out a second canopy from a stem normally clean up to the first branch.

Australian Official Photograph by J. Gallagher.

undergrowth ; and, if it is a year of the karri flow, it assists in the germination of the seed. Sometimes in a lean year the tops are held over for burning until there is a good fall of seed.

Having assisted at the birth of the trees and guided the first few years of their lives, the Divisional Officer and his troops are faced with the task of bringing them safely to maturity. In this their most unrelenting adversary, the one which strikes most shrewdly, moves most swiftly and destroys most wantonly, is fire. Nobody who has seen a forest in flames will ever forget it – the searing glare of the holocaust, the terror and suffering of bush creatures, the demoniac noise. If, as some say, the great trees groan heartrendingly in felling, they scream in the embrace of fire.

In combating it, the foresters employ the oldest and the newest measures. The oldest method is a sort of primitive tree-dwelling perched in what seems to be a most precarious fashion at the sawn off summit of a mighty karri. This lookout tower is a 6 feet by 6 feet prefabricated hut that is hauled whole to the top of the tree and bolted there. Equipped with telephone, telescope, lightning conductors and maps, it overlooks tracts of forest up to 60 miles away.

There are several of these lookout trees scattered throughout the area ; one of them, the Diamond Tree, is lopped off at 158 feet and at the top has a wooden tower which raises the height of the lookout to 178 feet.

The ladder between top and bottom is the first move in the construction of the lookout. At the base of the tree the forester bores a hole in which he inserts a four feet long 3 inches by 2 inches karri peg. Sitting on that, he inserts a second, similar peg 2 feet 6 inches above it, and so on, spiralling around the trunk, to the top. During this operation he is roped by the waist to the tree.

On the way down, he drives between each of the wooden pegs a metal pin of the same length and a second row of pegs a couple of feet away from the first. Steel wire is threaded criss-cross from peg to peg, the result being an enclosed staircase from the bottom to the top of the tree.

The new approach in the battle against fire includes the most modern methods of prevention and control – telephone, radio, tele-radio, meteorology, motor transport and various types of pumps and sprays. The heavy duty fire truck is a four-wheel drive vehicle capable of carrying a 600 gallon tank of water fitted with a Hale pump ; under normal conditions the water will last for 20 minutes, but the pump, which will send a vertical jet 90 feet is capable of spraying 120 gallons a minute.

The centre of communications is the tele-radio at Divisional Headquarters, which is standard equipment for 13 control centres throughout the State. Sixty-one trucks in the service of the Forestry Department are fitted with a modified Army type set so that when a fire is located by one of the lookouts the outlying gangs are readily contacted and can assemble their maximum resistance at the point of greatest danger.

Telephone communication is between lookout trees, Divisional Headquarters and out-stations.

To be forewarned, the Divisional Officer keeps a close liaison with the State weather bureau and receives readings from a number of forest centres each day. In addition, at 4–15 each afternoon the weather forecast for the following day is broadcast over the Forest Service Department network ; at 7.30 each morning, weather readings are radioed from Pemberton, Ludlow, Narrogin and Margaret River, all forest centres, to the Forestry Department's main subsidiary weather station at Dwellingup. On that information, an up-to-date assessment of the fire hazard for the day is broadcast from Dwellingup at 7.45 each morning.

On that assessment is based the plan of the day, the distribution of fire gangs and the schedule of radio operations. The actual fire hazard is related to the dryness of the atmosphere and is calculated from measurement of the moisture content of oven-dry pine cylinders weighing 50 grammes each. Each forest weather centre is equipped with a set of these cylinders, which are weighed every two hours. On a day of severe hazard, radio schedules are continuous, but on a mild day only every two hours.

During 1951–52, Departmental gangs attended 324 fires. Of these, only four were of the type that sets the alarms ringing in every heart in the timberland, when the sky in dark at mid-day, and even people in the cities anxiously scan the papers for news of the battle. Careless hunting and fishing parties started 29 of them, bush workers nine, mill locomotives 48 and children six. The rest were ascribed to a number of causes ranging from lightning to escapes from control burning; inconceivably, 41 were deliberately lit. The forests have enemies other than the summer sun.

To combat these infiltration tactics and to ward off the ultimate major assault, the Department's troops last year prepared, 1,268 miles of fire breaks and buffer strips. Areas of dangerous hazard totalling 150,000 acres were burned. Mill villages, forest settlements and isolated bush schoolhouses were burnt around as protection against uncontrollable fires; twenty-seven fire-towers or lookout trees were manned during the season and three more trees for use next year were selected and pegged.

It is a stern and unending battle, but the prize is great. During 1951–52, nearly 10,000 Western Australians earned their living in the State forests as fellers, haulers, pole getters, cooks, contractors, field staff and office workers. The value of forest products in the period was £A8,500,000, and the production of sawn timber, 14,717,112 cubic feet, reached a total never before exceeded in the State.

It is a battle that will never truly be won, but neither will it be lost. The C.O., the N.C.O.'s and the "lance corporal and party of six." will see to that.

A SIMPLE METHOD OF MEASURING BOLE LENGTHS AND HEIGHTS OF SMALL TREES

BY K. V. KAKKAR, M.SC., A.I.F.C.
Assistant Conservator of Forests, U.P.

Introduction—While doing markings, the marking officer generally carries a long bamboo of known length, and he determines the lengths of commercial boles and heights of trees in terms of the number of sections the bamboo will take off. The lengths of commercial boles are required in order to find out whether a tree is sound, fit or unfit. This method is not only crude but it also entails expenditure on the maintenance of one extra coolie for the carriage of the long bamboo. The following method, which is based on the principles of certain 'range finders*' used by photographers, has obvious advantages on the aforesaid method in that it is comparatively quick and fairly accurate. The apparatus costs nothing and heights can be read straight away on the scale without the help of a second man or a long bamboo pole. The only disadvantage in this method is that for heights of more than 50 feet the graduations in the scale become very close to one another and the accuracy decreases. It is very good for finding bole-heights and it can also be used for measuring heights of small trees provided their top is visible from a short distance from the bottom.

Method—The graduated scale shown in Fig. 1 is traced out on a piece of cardboard or thick paper. The observer stands at fixed distance say 5 feet (for which distance the scale in Fig. 1 has been graduated), from the tree. The scale is held out in one hand and the arm is fully stretched (Fig. 2). The right eye is closed and the zero of the scale is made to coincide with a point on the top of the bole. The right eye is now opened and the left one is closed, keeping the scale in the same position. The point on the bole will now appear to have shifted to a division of the scale other than zero. This division of the scale gives the height directly.

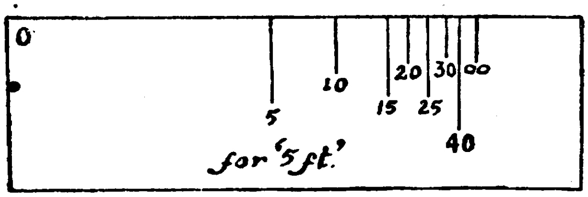


fig. 1.

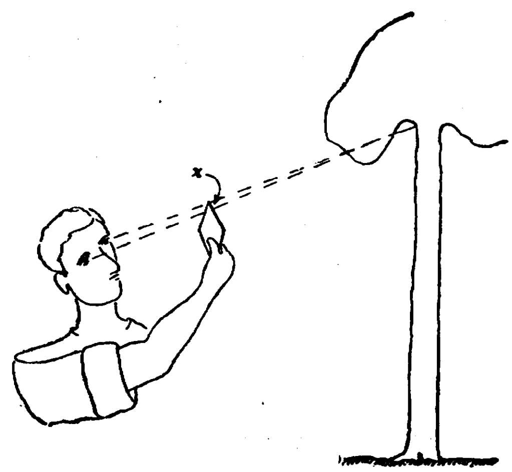


fig. 2.

It is to be expected that the scale will read different heights with different observers, as the arms length, height of observer, and the distance between the two eyes vary from man to man. It is necessary, therefore, that each observer should make his own scale according to the method explained below :—

Construction of the scale—On a vertical wall or the straight bole of a tree mark some known heights – 5 feet, 10 feet, 15 feet, etc., etc., by actual measurement. Stand close to the

* The Amateur Photographer, July 12th, 1939. P. 32. " A simple range – finder " by Moxby.

tree at a fixed distance, say 5 feet from it. It is not necessary that the distance should be 5 feet. You can measure any fixed distance, say two lengths of your walking-stick or 4 paces (if you are confident of your steps). But in each case this distance must be kept in mind while making the actual observations.

Take a piece of blank cardboard and mark on its left edge "zero" ; close the right eye and hold the cardboard towards the five-foot mark with your arm fully extended, and shift till, as seen with the left eye, the scale coincides with the mark. With the cardboard held in the same position open the right eye and close the left one. The point on the cardboard through which the five-foot mark is sighted should be marked '5'. Similarly the scale is calibrated for heights of 10 feet, 15 feet, 20 feet, etc.

Theory—The basic principle behind is that of similar triangles. This is illustrated by Fig. 3. The left eye, E_1, sees the object 'O' in the direction E_1O, while the right eye sees it in the direction E_2O. AB is the cardboard piece. If O is sighted through 'A' by the left eye and through 'B' by the right eye and OM and ON are the perpendiculars from 'O' to AB and E_1E_2, we have from similar triangles OAB and OE_1E_2 and triangles OAM and OE_1 N,

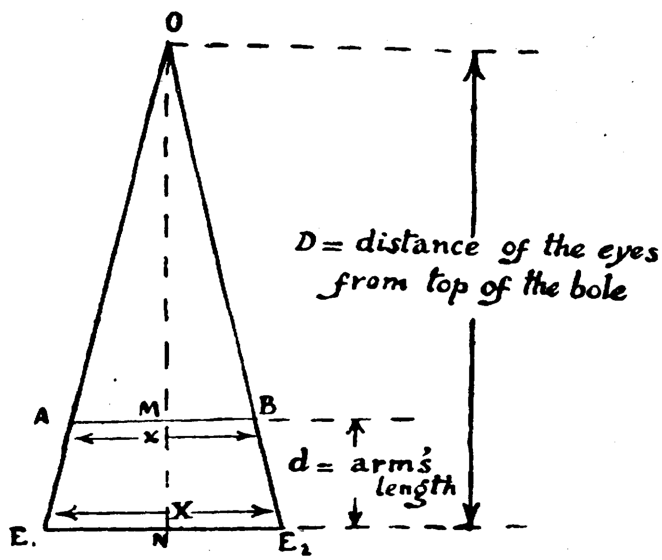


fig. 3.

$$\frac{E_1 E_2}{AB} = \frac{OE_1}{OA} = \frac{ON}{OM}$$

If ON = D, MN = d, E_1E_2 = X, and AB = x, $\frac{D}{(D-d)} = \frac{X}{x}$

d is known as also X and x. From these, D, the distance of 'O' from the eye, is found. Now the eyes are always to be at a fixed horizontal distance from the bole. Knowing this horizontal distance and the inclined distance D, as found above, we can calculate the height of 'O' above the eye-level, and add to it the height of the eye-level to get the height of 'O' from the bottom. The calibrations as above made, however, do away with the need for these computations. This method will also be found to be useful for estimating heights of walls and buildings.

THE *MURIA* NOMENCLATURE

BY S. D. N. TIWARI, F.B.S., S.F.S.
Working Plan Officer, North Bastar Division, M.P.

As most of the old survey of India maps which were prepared in the last century were not found correct we had to do resurvey and mapping. Naturally the interest in recording the names of hills, *nalas,* blanks, etc., was much more than in normal course of working plan survey.

The *Murias* (the aboriginals of Bastar) have a definite system of nomenclature and they provided names even for small *nalas* in the interior of the vast stretches, of forest. The name is first given to the hill or Mountain in the area (known as Dongri) or a flat topped hill (known locally as "*Mari*"), e.g., *Karkatti Dongri, Amraoti Dongri,* etc. The *nalas* are named after the hill of their origin and all the tributaries of one *nala* have the same name. If more than one *nala* flowing in different directions originate from one hill, one of them is named after that hill and the rest on the basis of some other characteristics. When these small *nalas* pass through some villages, their names change after these villages and thus one *nala* may have several names till it reaches fairly big size. The Bastar sal forests are characterized by large blanks due to shifting cultivation done in the past. Most of them were under cultivation. They have been named after the hills in the vicinity or independently if there are no hills in the locality. The *nalas* passing through them are generally named after these blanks. The nomenclature of the hills, the blanks and those *nalas* which have been independently named is very systematic. Most of them have been named after the characteristic plants or trees growing there – either in abundance or rare but very useful. Thus there is *Aonla Dongri* with very large number of *Aonla* trees on it; *Khirsari Dongri* with many *Khirsari* bushes (*Nyctanthus arbortristis*), *Bada-jhodi* with one big *Bada* (*Ficus bengalensis*) tree along that *nala*; *Alibeda* with one old and big *Ali* tree (*Ficus religiosa*) in that blank, etc. Whenever I was given the name I enquired about its significance. In the case of *Alibeda* I went to see the tree and learnt that *Ali* meant *Pipal* in Gondi. There were more than one surprises during my enquiry. On *Dhaora Dongri* instead of *Dhaora,* sal was found and my *Muria* guide shyly explained that *Dhaora* used to be once abundant there. The same thing was found about *Aonla beda* where no *Aonla* trees are now noticed. The reason for such absence is perhaps ecological succession which has taken place since the first nomenclature. But it was more interesting to have discovered a few, rare spp., in the locality which might have been otherwise missed. There is no cane in Kondagaon *tahsīl* or even within the radius of 80 miles of the locality and when the name of one *nala* was given as "*Bet beda dodi*" I was simply surprised if cane could be found in that locality. My guide took me about half a mile to the head of the *nala* and showed me the few cane bushes which were fast approaching their final end, due to heavy cutting, summer fires, and grazing. It is quite likely that in olden days the whole locality was full of cane and as the villages settled in its vicinity it started dying out due to the above factors. If no protection is provided to them, this one spot of cane will also soon disappear.

Another discovery was of *Sideroxylon tomentosum* – which later I saw only at Bailadilla which is about 122 miles south of the place. There were hardly 2 to 3 miserable bushes and my attention was directed when they gave me the name of one *nala* as *Gaja-Harra-Dodi* and explained that a few small trees of *Gaja-Harra* were growing along it. The fruit of the plant is used as vermifuge for children. These bushes are also on the verge of dying out as perhaps the ecology of the place is changing due to more habitation.

I discovered *Deodhan* "*Oryza granulatum*" in the bed of one of the *nalas* only with the help of its name *Deodhan Dodi*. The species is not very common in the locality.

Some names yield very interesting information. There is one *Tiwas-Sar-Dongri*; *tiwas* = *Ougenia dalbergioides*, *sar* = *marhan*, i.e., shifting cultivation for light crops; *Dongri* = hill. This hill has been named after *Tiwas Sar* which just adjoins it. *Tiwas Sar* used to be a Manher field about 40 years ago and there were lot of *tiwas* trees in the locality. When I went to see the place I was pleased to note the correct nomenclature. When I enquired as to why the fields were abandoned, the guide replied that it was at the time of reservation that they had to abandon them in exchange for land in the vicinity. I could thus calculate the date of abandoning the fields and study the ecological progression which took place in the area.

Names after rocks do not lack. There are *Pandri Dongries* (white hill) on which quartzite pieces are found littered giving it a white appearance. There is *Pakhna Dongri* on which large boulders of granites are found.

There are many places inside the forest where deep gullies are found. *Muri* calls them *Kohra* and where the number of gullies is ordinary they have named the *nala* as "*Sat Kohra*" (Sat = 7) "*Dodi*" while at places where the cutting is excessive they have named it "*Barha Kohra*" (Barha = 12). Thus from the name one could expect gully erosion and poor quality forest in that locality.

Some places have been named after their peculiar sizes, e.g., one hill had a name as *Lambi Dongri* due to its long length. Wild animals have also not escaped attention. Near Mailbeda, one *nala* has a name as *Barha Dodi* (Barha = Wild bear) on enquiry it was found that once upon a time wild bears were found along its banks. Wild bear is one of the favourite games of the *Murias* and perhaps the name attracted more "*Parad Gangs*" (*shikar* parties organized by the aboriginals) and destroyed them. More sense appears to have dawned on them earlier and there are very few names after the wild game, the flesh of which is relished by them. On the contrary there are large number of *Bhalu Dongries* (hills haunted by bears) *Bagh* (tiger) *Dongri*, and *Bagh Dodhis* and the forest wanderers are thus cautious when they pass by them.

Many incidents are celebrated by naming a place. The name of one *nala* was given to me as *Bagh Dodi* along with the comment that the old name of the place was *Sat Kohra* but as recently the *nala* was haunted by a cattle lifter and a beat was arranged to kill the same the name was more appropriately changed to "*Bagh Dodi*".

One of the incidents during our stay was also celebrated by a name. One party was doing enumeration in a locality during summer where one man-eater tiger used to haunt. It retreated up to the foot of a high hill but when the party was approaching this place the tiger roared and rushed at the party as it did not want to go on the rocky hill and leave the cool shady place. All the people ran away. Next day, when I asked the guide to take me to that place he enquired if I wanted to go to "*Bagh-Darawale Dodi*", i.e., the *nala* near which the tiger rushed. The small *nala* had no name before and the name coined by the *Muria* was thought to be the most appropriate and was accepted.

There are practically no names after individuals which is rather peculiar as such names are common in other districts. I have been searching for the reason and the only one I could find is that a *Muria* hates to exploit, to be exploited and to quarrel. Each village gives its own name to an object and does not worry about the name given to the same object by another village. This is why one *nala* flowing through different villages has different names. The

villager when he goes to another village seldom disputes the names given by those people. Similarly, different names may be given for a certain hill by the villagers of two different villages specially when there is no significance attached to the name and when the hill lies away from the village in the forest more or less equidistant from them. However, the name is hardly disputed if the hill is near a certain village. But in the case of names with some significance there had hardly been any contradictions, e.g., names like *Bhalu Dongri*, *Deodhan Dodi*, etc.

We may call the *Muria* backward, but here is one subject, the nomenclature in which he excels and is definitely much superior and scientific. Ecologists, *Shikaris* and Naturalists will always thank him for providing a natural history of the place in a name. There were many *nalas* and hills which had no names and we left it to the *Murias* to coin suitable names for them in due course of time.

FINANCIAL ASPECT OF ARTIFICIAL TEAK PLANTATIONS IN THE KANARA DISTRICT OF THE BOMBAY STATE

BY E. K. KOTWAL
Conservator of Forests, S.C.

A short review of the teak plantations in Kanara throws a very illuminating light on the economics of raising teak plantations and their prospective value. Kanara contains some of the oldest plantations in this State. The Kadra-Mardi-Sulgeri Teak Plantations in Kanara Western Division were created in 1866–1882 by Mr. Barret, the then Divisional Forest Officer and 712·06 acres were planted up. The initial planting was 9 × 9 feet. The initial expenditure and revenue realized so far are as follows :—

Block I to V		712·06 acres	
Expenditure incurred	Rs.	Revenue realized from thinnings	Rs.
Up to 1908–09 ..	85,563	Up to 1908–09 ..	8,604
From 1909 to-date ..	1,205	From 1909 to-date ..	57,117
TOTAL ..	87,768	TOTAL ..	65,721

The present crop consists of teak trees ranging from 4 to 9 feet 3 inches in girth. There are thousands of Teak trees spread out all over the area and many of 7 feet girth are seen. As detailed enumeration figures are not available it is not possible to give the exact stocking in the various girth classes. The Forest Research Institute have laid out sample plots in these areas. The prospective value of these very valuable plantations is very promising.

2. Another very old plantation in N.D. Kanara is Barchi plantation of 206 acres (in VI–16A) artificially created between 1881 and 1890. It was thinned in 1929–30 at a cost of Rs. 3,028 and revenue realized from this material was Rs. 10,187. Thinnings in 1942–43 were done at a cost of Rs. 1,038 and the resultant rejected material from this thinning was sold for Rs. 4,000, whereas the teak logs, poles and other material sent to Dandeli Depot for sale have realized a very good price. The particulars of the teak logs, etc., are given below which indicate that @ Rs. 400 per ton for teak logs alone, the whole lot of teak logs (197·00 tons) having realized a splendid revenue of about Rs. 79,000 is a very high dividend indeed paid by this plantation :—

	Logs	Poles	Other material
	Tons	Tons	Tons
Teak ..	197·05	3232·25	952·70
Sissum ..	34·10	..	30·80
J. wood ..	220·82	7·0	..

The present stocking is about 80 trees per acre and the average girth 44 inches and average height 64 feet. The plantation if cut would yield 20 tons per acre and the total yield would

be about 4,120 tons which would yield a revenue of Rs. 11,53,600. Thus it shows the high revenue our teak plantations are likely to realize in the near future.

3. The cost of formation of most of the current plantations is easily recoverable from the 1st and 2nd thinnings. The following figures would give some idea :—

Division	Bl. and Compt.	Year of planting	Area planted	Total cost incurred	Total value realized
			Acres	Rs.	Rs.
N.D. Kanara	I-6(d)	1937	99·00	4,057	12,500
	XI-22	1941	15·00	1,166	2,201
	IV-20	1940	108·00	10,417	12,900
	V-1	1941 1942	20·00 20·00	3,187	8,400
	V-1	1939	20·00	1,958	18,602
E.D. Kanara	F.S.V. R.A. 1	1937	85·00	4,057	5,765
	F.S.V. R.A. 2	1938	72·00	3,518	8,345
	F.S.V. R.A. 3	1939	69·00	4,458	5,005
	F.S. III R.A. 3	1939	63·00	3,362	3,385
	F.S. I R.A. 1	1937	70·00	2,722	3,162
	F.S. IV R.A. 1	1937	50·00	2,236	2,475
	F.S. IV R.A. 2	1938	50·00	2,297	2,525

FURTHER REMARKS ON THE DISTRIBUTION OF THE LANTANA BUG, *TELEONEMIA SCRUPULOSA* STÅL (HEMIPTERA, TINGIDAE) IN INDIA SINCE ITS INTRODUCTION IN 1941 FROM AUSTRALIA

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I. REMARKS

In 1941 the Lantana Bug, *Teleonemia scrupulosa* Stål (synonym *T. lanatae* Distant) was introduced into Dehra Dun (the Western Himalayas, North India) from Australia under quarantine conditions in order to try it for the control of the Verbenaceous weed *Lantana aculeata* Linn. (synonym *L. camara* Linn.). After 3 years of experimentation it was found unsuitable and the entire remaining stock of live bugs was destroyed. But there were evidently some escapes ; and specimens were accidentally found in Dehra Dun in August 1951. A subsequent survey of Dehra Dun and its vicinity in 1951–52 showed (Roonwal, 1952) that the bug was well-established and freely breeding on *lantana* bushes in Dehra Dun and up to at least 26 miles south of that place.

In order to find out the extent of dispersal of *Teleonemia scrupulosa* from the centre of its original accidental release, viz., Dehra Dun, a circular letter was addressed in November 1951 to all the forest departments in the various States of India with a request that they might survey lantana bushes in their respective areas and collect the Lantana Bug if it occurred there. Replies were received from all the States. Some of the States sent insects found on lantana which, however, on examination did not prove to be *Teleonemia* ; others replied that no such bug was discovered by them. In Uttar Pradesh, Prof. M. S. Mani kindly conducted a survey of Agra and its vicinity and Dr. P. D. Gupta of Lucknow. The Government Entomologists of Bengal, Madhya Pradesh, Madras, Mysore and the Punjab surveyed areas in their respective States, and Dr. A. P. Kapur surveyed Ranchi and its vicinity in Bihar. In addition, I personally surveyed lantana bushes in several areas in Ajmer, Bihar (Ranchi and its vicinity), Rajasthan (Kotah, Jaipur and Jodhpur) and Uttar Pradesh (Lucknow). Altogether, the following areas were surveyed and yielded negative results (with the exception of Dehra Dun and vicinity already mentioned) as regards the presence of *Teleonemia scrupulosa* :—

Ajmer	.. (Ajmer city and vicinity ; Ajmer Forest Range).
Assam	.. (Khasia and Jaintia Hills Forest Division).
Bengal	.. (Asansol, District Burdwan ; Rampurhat, District Birbhum ; Tollygunge, Calcutta ; Arabari Forest Range, Midnapur Forest Division).
Bhopal	.. (Various forest divisions).
Bihar	.. (Around Ranchi).
Bombay	.. (Various forest divisions).
Coorg	.. (Various forest divisions).
Himachal Pradesh	.. (Various forest divisions, including that of Nahan).
Madhya Bharat	.. (Indore Forest Division).

Madhya Pradesh	..	(Nagpur ; Umaria).
Madras	..	(Dankanikota Forest Range ; Coimbatore and its vicinity).
Mysore	..	(Bangalore and its vicinity).
P.E.P.S.U.	..	(Kandaghat Forest Division).
Punjab	..	(Palampur, District Kangra ; Hamirpur Forest Range).
Rajasthan	..	(E. & W. Rajasthan ; Bundi ; Kotah ; Jaipur ; Jodhpur).
Travancore-Cochin	..	(Vilavancode *tāluk*).
Uttar Pradesh	..	(Agra and its vicinity ; Chargaha-Nandham Forest Range ; Lucknow and its vicinity).

From these records the Lantana Bug may be presumed not to have spread during the period of about 10 years covered by its escape (which occurred during 1941–1943) and by the present surveys (1951–52), beyond the 26-mile area from Dehra Dun southward. We also get an idea of the average rate of dispersal and establishment of the Lantana Bug which works out roughly at 26/10 or about 2½ miles per year in one direction from the centre of dispersal.

II. SUMMARY

1. From an All-India survey conducted in 1951–52, largely with the assistance of the forest and agricultural departments of the various States, it appears that the introduced species of the Lantana Bug, *Teleonemia scrupulosa* Stål, in India has, during a period of about 10 years (1941–43 to 1951–52), become dispersed and established not more than about 26 miles from its centre of dispersal, viz., Dehra Dun.

2. The average rate of dispersal and establishment thus works out at about 2½ miles per year.

III. REFERENCE

Roonwal, M. L., 1952. The natural establishment and dispersal of an imported insect in India. The Lantana Bug, *Teleonemia scrupulosa* Stål (= *lantanae* Distant) (Hemiptera, Tingidae), with a description of its egg, nymph and adult. — *J. Zool Soc. India*, Calcutta, 4(1), pp. 1–16.

NOTE ON *CASUARINA JUNGHUHNIANA* WITH SPECIAL REFERENCE TO ITS EXPERIMENTAL INTRODUCTION INTO INDIA

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There is one Casuarina indigenous to Thailand, i.e., *Casuarina equisetifolia*, Linn, which grows more or less gregariously on the sandy beaches along the coast line. There has been in cultivation, however, throughout the country one exotic Casuarina, reputed to be introduced from Indonesia some 40–50 years ago. The plant is conical in form, straight with somewhat laxing leaves, easily distinguishable from *Casuarina equisetifolia*, which is wide-spreading in habit with thicker foliage. It is obvious that the plant is diœcious, since only male flowers are borne on the trees naturalized in Thailand.

A. NOMENCLATURE

In Thailand the plant is known by a common name of *Son Pradiphat* while *Son* refers collectively to the conifers, *Pradiphat* is the name of a nobleman, who played an important part in the introduction of the plant during the great King Rama the Fifth's reign.

In 1948 the tree was arbitrarily named *Casuarina cunninghamia* by the F.A.O. Mission for Siam as appeared in their report page 81 together with a photograph.

More recently, however, through the good offices of the F.A.O. Regional Office, the tree has been identified by the Forest Research Institute, Bogor, Indonesia as *Casuarina junghuhniana*, Miq. var. 5. (Syn. *C. montana*, Jungh.). The following is an excerpt from the note : "In the lowlands of Java a variety of *C. junghuhniana* (classified as 'var. 5') is cultivated, from which no material is as yet available from wild trees. This variety excels in its stem form resembling in its erect branches a pine tree. As a rule such trees do not exceed 35 M. in height and 50 CM. in diameter. They entirely match your material from Thailand : long 'needles' 7–8 leaves in a whorl, male inflorescenses".

Subsequently, however, further developments in nomenclature were cleared through Mr. C. Purkayastha to the effect that the specimen formerly identified by Bogor, Indonesia as *C. junghuhniana*, Miq. was identified by Mr. Johnson of Australia as a hybrid namely : *C. equisetifolia*, Linn, *X. junghuhniana*, Miq. Thus the matter rests for the present, and 5 grms. of seeds of *C. junghuhniana* was obtained from Timor by Mr. Purkayastha and forwarded for trial propagation in India. It would be indeed interesting to compare the outcome of this consignment with the controversial Casuarina naturalized plant of Thailand.

B. UTILIZATION IN THAILAND

The tree is cultivated everywhere as an ornamental, usually in rows along the roads or fences. It also can be trimmed as hedges and into various shapes in the garden. It responds very well to good friable loam, but shows a remarkable power of adaptability in all kinds of soils and locations. Its main economic use at present, however, is for fishing stakes at sea, in which a height of from 10 to 20 metres is required. It is also being tried for paper pulp. The timber has no heartwood, pale brown in colour and weighs 28·9 KG. when green and approximately 21·3 KG. or 47 lbs. per cubic foot when air-dry. To provide the fishermen with their fishing stakes, the Royal Forest Department establishes a series of plantations on the poor sandy beaches along the west coast of the peninsula. From the 8th year onwards the thinnings can be sold to the fishermen at a highly lucrative price.

C. INTRODUCTION INTO INDIA

While touring India in 1950 under the U.N. Economic Development Fellowship, the writer had occasion to inspect *Casuarina equisetifolia* plantations for firewood in Madras and Mysore. The writer was impressed with three main problems that his Indian collegues had to encounter namely :—

1. the comparatively bigger casualty, due no doubt in no small measure to the more trying conditions of climates and soils ;
2. the strikingly poorer growth manifest especially during the first 3 years of planting ; and
3. the prevalence of die-backs in established plants diagnosed as due to some form of fungi attack brought about perhaps to a certain extent by physiological irregularities.

To remedy the above difficulties the writer suggested the trial planting of *Casuarina junghuhniana* cuttings from Thailand. The idea is to plant a bigger shoot with more vitality to thrive under trying conditions prevailing during the first two years. It was also advanced that the cuttings when planted will have the advantage of growth equal to the 2 or 3 years old *Casuarina equisetifolia* seedlings propagated from seeds. This initial advantage is all the more important in view of the fact that the plantation is usually formed in arid areas, where a bigger well-grown plant stands a much better chance of surviving the very harsh elements. The plants are also expected to be free from disease. The recommendation was very favourably received by the various forest officers from the Divisional Forest Officers in charge to the Chief Conservators of the Provinces. Contact was, therefore, made through the Forestry Working Group of the F.A.O. for Asia and the Pacific, Bangkok.

The first consignment of 100 rooted cuttings of *C. junghuhniana* was despatched by air-freight to India in early 1951. The second shipment of 600 cuttings subsequently followed in 1952. In both cases the cuttings were supplied free of charge by the Royal Forest Department, Bangkok and thanks are due to the very effective co-ordination from the forest officers of the F.A.O. Regional Office.

D. FIRST REPORT FROM INDIA (MADRAS)

It was later ascertained that the first shipment of 100 cuttings in 1950 was sent over for propagation in Madras Province. Through Mr. C. Purkayastha, Chief Forestry Working Group for Asia and the Pacific, a copy of the first report on this consignment was received by the writer with the request that his comment on the several pertinent aspects would be greatly appreciated. Hence this note. Before proceeding to the specific themes of interest, however, it would be proper also to mention the fact that the writer himself had the occasion to visit the Casuarina plantation centre at Markhanam Range, Chingleput Division, in his tour of the Madras Province in 1950. This subject, therefore, is special interest to the writer personally as well as professionally.

From the report No. 2110/51 U. dated 30th June 1953 of Mr. B. A. Cariappa, District Forest Officer, Chingleput and the covering letter of Shri V. V. Subramanian, I.C.S., Chief Conservator of Forests, Madras to Mr. C. Purkayastha the following salient features come out.

1. The 100 cuttings received by Madras in 1951 were divided equally between Nellore Division (Sriharikota Plantations) and Markhanam Range, Chingleput Division. The Nellore lot completely failed. In Chingleput Division, however, of the 50 cuttings received, 21 cuttings were successfully established.

2. The 50 cuttings were received by the Range Officer, Markhanam on 3rd July 1951. Actually the cuttings were severed on 12th June 1951, reached Bangkok on 15th June 1951 and delivered to the F.A.O. Regional Office for despatch by air-freight on 23rd June 1951. Thus fully 21 days elapsed from the time of cutting before they were heeled in at Markhanam.

3. The cuttings were planted 2 feet apart in a nursery bed 40′ × 4′ on 4th July 1951, and watered profusely twice daily till 15th October 1951 (101 days). Altogether 21 cuttings survived.

4. Of the 21 cuttings planted 2 feet apart on 17th November 1951 (135 days from planting) eleven plants were transplanted to relieve congestion. A very vigorous root system was observed ; the average height of 5 plants observed was 5 feet 2 inches while the longest root averaged 7 feet 2 inches, and this within 135 days of planting in the nursery.

5. The height growth of the 21 trees as recorded from time to time was really phenomenal as per the following summary.

		metre	*feet*	*inches*
Mean height at planting	(4–7–51)	0·73	2	5
4 months 13 days old	(17–11–51) average height	1·62	5	4
	Best height	2·03	6	9
	Lowest plant ..	1·01	3	4
9 months 11 days old	(15–4–52) average height	2·87	9	5
	Best height	3·50	11	6
	Lowest plant ..	2·03	6	8
20 months 1 day old	(5–3–53) average height..	5·00	16	5
	Best height	6·40	21	0
	Lowest plant	4·57	15	0
	Average height increase ..	4·27	14	0

6. Propagation by burial layering was quite successful ; the layered cuttings were observed to possess a very well-developed root system.

Discussions on the propagation methods and growth figures as practised in Thailand, in the light of the novel experience contained in the foregoing report, are presented below under the separate headings.

E. VEGETATIVE PROPAGATION

(1) *C. junghuhniana* as existed in Thailand possess only the male inflorescence ; hence the only mode of propagation possible is by vegetative process. Mature trees throw out runners from roots, that can be further propagated. This mode of propagation, however, is of much less practical value than the marcottage of lower branches, which will be described in detail later.

Cuttings of lower branches have been induced to take roots by the treatment with many root-taking hormones, with so far only negative results. The experiment, however, continues with the objective of checking up some of the possible loopholes in the former trials, and giving the treatment a thorough trial before concluding.

(2) Propagation by marcottage or *gootee-layering* of lower side branches is generally successful and practical. The universal practice is to select a healthy branch with well-ripened wood about the size of the small finger (circumference between 0·5 to 1·5 CM.). Immediately after a leaf bud or node and about 5 CM. or so from the main trunk, ring off the bark to a width of about 1 CM. Scrape off all cambium layers. Leave the wound for 5–7 days to ensure that the growth in the branch is totally arrested. Then cover the wound with a ball of adhesive soil and hold it securely with an outer layer of coir fibre saturated with water. Tie up at both ends and keep it well watered morning and evening when there is no rain. About 10–15 days the roots will show up through the coir fibre. Allow the twig thus to be well rooted before cutting out for potting.

(3) As a rule *C. junghuhniana* responds well to the above propagation method. The practice, however, has some drawbacks ; namely : to ensure a success, propagation is usually carried out only in the rainy season so that watering is not very necessary. On the other hand out-of-season marcottage can be successfully practised only with the added cost and precaution of periodic watering to prevent the drying up of moisture.

With the objective of lessening the cost of watering and making it possible to carry out marcottage at any time of the year, the writer adopted the recent American practice of plastic cloth and moss in early 1952 with very satisfactory result.

In the improved technique Sphagnum moss was employed instead of adhesive soil and instead of the coir fibre, a waterproof piece of ordinary plastic cloth is used, thus keeping the moisture in the Sphagnum for as long as 30 days without any need for further watering. As the initial trial was highly successful, the process is now undergoing field tests to verify the result in various localities. Repetitions of the experiment are also being carried out for the different seasons of the year, i.e., rainy season, cold season and hot season, to check up the performances of the technique in different climatological conditions.

(4) The recent improvisations in the method worthy of notice is the use of coir fibre instead of the Sphagnum moss which is not so readily available everywhere. The results obtained so far prove practicable at least for the rainy season.

(5) Following the above trials the plastic cloth technique of marcottage is thus strongly recommended to the Indian forest officers for trial with their stock of *C. junghuhniana* successfully established at Markhanam and elsewhere.

As the cost of transportation of Casuarina cuttings in number is prohibitive and the chance of casualty in transit and handling necessarily high, the appropriate procedure would be to establish a few trees at each of the plantation centres and further propagate from the side branches of the existing trees.

F. NURSERY PRACTICE AND PLANTING

(1) After severing from the mother trees the rooted cuttings should then be kept in pots or bamboo baskets, stored in partial shade and well watered at least for one month before they are planted out. The cuttings should then be about 1 foot 6 inches to 3 feet high, depending on the period of potting and the time of planting.

The size of the bamboo basket varies with localities, but as a rule the bigger-potted and longer-kept plant has a better chance of more vigorous growth.

(2) The Indian practice at Markhanam, Madras, differs from the Thai method very markedly at this juncture ; namely :

(*a*) Cuttings were immediately set out in the nursery instead of potting in shade for at least one month as in Thailand. It was also deduced from the size of the

cuttings that the nursery bed is an open one. Take into consideration also the very severe hot weather of the Madras arid areas during early July. On top of all these consider the fact that the poor cuttings came off the branches since 12th June 1951 in Thailand, and had to undergo a period of extremely gruelling tests through several transportation channels, fumigation, customs and inspections on their way to Markhanam.

It was rather remarkable, therefore, by the Thai standard that the 21 cuttings managed to survive the ordeal, a phenomenon which would acclaim the conscientious manners of watering and general care, bestowed on the cuttings by the Indian foresters in charge.

(*b*) The technique of planting is also different. The Thai practice is to ensure a sufficient intervening period of rehabilitation and initial growth under partial shade before the plants are set out in bamboo baskets with no disturbance to root system. This precaution is to ensure that the cuttings planted will be able to put on enough growth and vitality during the rainy season to survive the difficult summer period to follow.

The practice is, therefore, recommended for adaptation to the Indian conditions, especially in the dry areas, where the very harsh climatic conditions and the high economic value of plants successfully established will no doubt warrant a somewhat higher expenditure and precaution entailed.

(*c*) It was not clear that transplanting of the 11 plants on 17th November 1951 (135 days after planting) was done by bare roots or with a ball of earth attached. The excessive length of root system (average 7 feet 2 inches) would suggest that rather the bare root or stump planting method was practised. Subsequent gain in height growth of the two batches, however, was remarkably identical, registering an average growth of 13 feet 2 inches for the 10 plants left undisturbed in the nursery and 13 feet 8 inches for the 11 transplanted plants.

It would be interesting to ascertain the missing details since the 100 per cent success of transplanting big plants (average height of 5 feet 4 inches) as late as November culminated in registering even a better growth (average better growth of 6 inches) for the transplanted cuttings. This may throw light on a better propagation technique as for example the transplanting of overgrown nursery plants as against the present practice, which ought to cost more.

(3) *Planting*—The land is cleared and the dry debris well burnt in the hot season preceding the monsoons. The area is then staked out usually to an espacement of 2 Metre × 2 Metre. If the potting is done in bamboo basket about 8 inches diameter, the bottom is slashed of and the plant is lowered into the dug hole together with the basket. The plant is then well firmed and tied up to the stake.

Watering is usually necessary in dry days depending on the locality until the plant is well established.

The Markhanam practice differs again in spacing which was 2 feet × 2 feet and 12 feet × 12 feet. While 2 feet × 2 feet is obviously too close the wider spacing employed is considered altogether too roomy.

G. RATE OF GROWTH

(1) *Thailand*—The following represents the rate of growth at Nong Kae 240 KM. South of Bangkok. It is one of the places of the lowest rainfall, having 117 days of rain totalling 38 inches. The configuration is flat sandy waste with small scrub and thorny bushes, considered

unsatisfactory for agriculture. It is also the centre, where afforestation with *C. junghuhniana* is most intensively carried out.

NONG KAE

Age	Height growth in Meter		Girth B.H. in CM.		Smallest	Mean
	Highest	Lowest	Mean	Biggest		
1	1·12	0·16	0·58	—	—	—
2	3·42	0·26	0·69	2·7	1·3	1·9
3	7·00	0·60	2·60	8·5	1·3	3·5
6	13·45	2·80	6·83	12·0	1·5	4·3
7	15·95	3·10	9·73	16·0	2·0	3·2
9	21·50	9·00	17·74	19·5	6·0	14·3

Growth figures at better sites with more rainfall and more percentage of loam in the soil are shown as under for the sake of comparison.

Age	Height growth in Meter		Girth B.H. in CM.		Smallest	Mean
	Highest	Lowest	Mean	Biggest		
1	1·98	0·25	0·83	—	—	—
2	3·80	0·44	0·92	—	—	—
4	14·00	2·00	8·55	14·2	1·7	5·9
8	21·50	9·00	17·74	19·5	6·0	14·3
9	23·75	11·00	20·39	21·5	6·0	15.6

(2) *Markhanam, Madras*—Comparing the height growth at the better sites in Thailand with the Markhanam Plantation, the following astounding set of figures is arrived at ; namely :

Particulars	Highest		Lowest		Mean	
	ft. in.	*metre*	*ft. in.*	*metre*	*ft. in.*	*metre*
1 year-old						
Thailand ..	6 5	1·98	0 10	0·25	2 8	0·83
Markhanam .. (9 months)	11 6	3·50	6 8	2·03	9 5	2·87
2 year-old						
Thailand ..	12 6	3·80	1 5	0·44	3 0	0·92
Markhanam .. (20 months)	21 0	6·40	15 0	4·57	16 5	5·00

The following comments are offered to explain and rationalize somewhat the very phenomenal growth as recorded.

(*a*) Roughly speaking the Markhanam Casuarinas far outgrows their progenitors in Thailand. Roughly speaking the average growth for the one-year old is nearer the figure for the 3-year old in Thailand ; and likewise the 2-year old approximates the means growth of the 4-year old. What is more astounding or in fact almost unbelievable is that the best height attained at 20 months of age by 4 of the 21 trees were 21 feet which equals the best height growth of an 8-year old in Thailand. Even the poorest growth managed to be up to 15 feet matching the best growth of a 4-year old in Thailand.

(*b*) Some of the discrepancies may be explained away by the fact that the Thai figures represent a much bigger number of trees grown under practical plantation conditions. Nevertheless the mean growth in height of about 10 feet at the end of the first year and 16 feet at the second year of growth are still exceptional even for plants grown in more favourable conditions in Thailand. In a sense the two sets of figures are so incongruous that any attempt at rational correlation is bound to be hopelessly inadequate.

(*c*) It may be likely that congestion in the early life may have forced an abnormal development both in height and root growth to some extent. But again just this single factor is not potent enough to justify the surprising height growth.

(*d*) Several Casuarina species such as *C. cunninghamiana*, *C. glauca*, *C. lepidophloea*, *C. suberosa*, *C. sumatrana* and *C. torulosa*, from Indonesia and Australia have been planted on trial from seeds, with the idea of procuring species that can surpass *C. junghuhniana* in the rate of growth. So far no species is in sight, and since the rate of growth put on by *C. junghuhniana* is better than the indigenous *C. equisetifolia*, it is evident that the transcendency of *C. junghuhniana* will be long maintained in Thailand.

It would be a very interesting proposition, therefore, to obtain seeds of this species from their natural home in Indonesia. By propagating from seeds the outcome will serve to verify the authenticity of the nomenclature, and also constitute added means of natural propagation, so that plants can be more quickly and probably more cheaply multiplied.

(*e*) It would be very interesting to follow the development in general well-being, in height growth as well in girth of these 21 trees, already so well established in India. Also the fate of the later shipment of 600 cuttings sent in 1952 is eagerly awaited. The facts and figures concerning all aspects of these plants are required for the correct evaluation of *Casuarina junghuhniana* as another valuable exotic for the Indian Forestry – and a contribution this time from Thailand, which from time immemorial was very closely allied to India in national culture.

In the meantime the Markhanam foresters are to be highly congratulated for the very successful care they have bestowed on the introduced plants. It is indeed specially gratifying to a forester to hear that his favourite plant is behaving beautifully in his collegue's care. Under the very encouraging circumstances as already happened with this Thailand Casuarina, the Thai foresters would pledge their fullest co-operation to make their plant an established success in India.

THE WHEEL OF DESTINY

BY SARDAR BAHADUR BALWANT SINGH
Conservator of Forests, PEPSU

1. Forests occupied a prominent position in the spiritual and cultural progress of India in the past. They provided an environment of peace and tranquility for the elevation of the mind and direct communion of the soul with the higher spirit. The Indian sages and saints, under the shadow of forest trees, searched for truth and having attained the goal, explained the philosophy of the spirit to the mankind. The greatness of India has its deep roots in that higher philosophy and learning which sprang under the shade of trees.

2. In the economic sphere as well, forest resources of a country play a very important role. They provide not only timber, firewood and fodder ; but also raw materials for essential industries such as softwoods for the manufacture of matches, plywood, bobbins, grasses and bamboos for paper and handicraft, resin, gums, lac and medicinal herbs.

3. Forests help in the conservation of soil fertility and play a prominent part in the maintenance of the water regime of the land. The success of the big river-valley projects, now under construction, is closely inter-connected with the preservation of vegetative cover in the catchments. The destruction of forest cover gives rise to floods of high intensity in the rivers and deposition of heavy loads of silt above the dam.

One of these gigantic projects, the Bhakra Nangal Project, now under construction at the foot of the hills near Nangal will cost the nation a sum of Rs. 156 crores. The catchment of the Dam lies in Kulu, Simla Hills, within the territorial boundaries of Himachal Pradesh, Punjab and PEPSU. The height of the Dam will be 680 feet and length 1,700 feet at the road level. The Dam will provide a reservoir for 5·3 millions acre feet of water. It will irrigate 36,00,000 acres of land in the Punjab, PEPSU and Rajasthan and generate 4,00,000 kws. of electric power.

4. The Siwalik hills of PEPSU in Kandaghat District, forming catchment area of Ghaggar, Sirsa Rivers and Patiala *Naddi*, present a puzzling entanglement of fissures, gullies, ravines and scrapped walls and are in a serious state of erosion causing heavy floods in rainy season and consequent loss of property and life. The damage done to the Railway line and washing away of Ghaggar Bridge in 1872 and complete destruction of the Railway line between Serai Banjara and Rajpura and loss of lives in Patiala in 1887 on account of floods from the Siwaliks are happenings of the past ; but it must be fresh to the memory of the readers that periodic floods in Patiala *Naddi* and Ghaggar caused serious damage to property and life in Patiala city and elsewhere in recent years as well. The Siwalik Hills are completely denuded of vegetative cover. The rain drops beat hard on the exposed soil, rush down the slope, join stream, cause floods and carry large quantities of earth, shingle and boulders. The absence of vegetation accelerates the velocity of the run-off and the erosive power and silt carriage capacity of the streams.

In the extreme western districts of the Union the Great Indian Desert of Rajasthan is extending at the rate of half a mile per annum and has advanced fairly deep into Mohindergarh District covering fertile cultivated lands with sand, thereby creating arid conditions. Sand dunes have been formed over a large tract, and agricultural production has decreased. Sand particles, whipped up by strong wind action, fan out as through a funnel, conveying a sense of frustration, agony and misery. The desert is fast heading towards Delhi. It also has affected

parts of Bhatinda, Barnala and Sangrur Districts; so-much-so River Sutlej has been pushed 30 miles towards North during the last century. This is all due to absence of forest cover.

5. The wanton destruction of forests has upset the agronomical balance, and has forced the cultivator in the plains to the pernicious habit of burning cow-dung as fuel instead of its application as manure for enriching the impoverished agricultural fields. The present supply of firewood from State forests as well as private areas, on a basis of sustained yield, is 35 lac mds., a year against the total requirements of 60 lac mds., for 6,65,510 persons inhabiting urban areas only, leave aside rural area. It clearly shows how insufficient and inadequate is the production of fuelwood.

Heavy fellings were made in private areas during the second world war on account of abnormal rise in the price of firewood and charcoal. Even the kilns, factories, and transport had to be run partly on firewood and charcoal due to short supplies of oil and petrol. After partition, the tenure of land allotted to refugees being temporary, indiscriminate felling of trees was resorted to, as everybody hastened to recoupe the loss suffered in Pakistan. The firewood obtained from felling of trees was diverted to towns and cities. In the course of the process of consolidation of holdings, village *shamlats* and common pastures are being partitioned and brought under plough. Trees are being cut ruthlessly everywhere and converted into cash. Consequently the consumption of cow-dung as fuel in villages has increased abnormally. The fertility of agricultural lands is falling, resulting in diminished yields. Urban population may satisfy part of their needs for sometime by substitutes such as coal, coke and electricity, if ample amount of these commodities can be spared from the fields of industry and transport, but rural people will be forced to resort to more cow-dung as fuel. What a sad state.

6. Thus it will be apparent to the readers that forests form an integral part of the economic fabric of the population and their conservancy is highly essential for our very existence. But this is a forgotten chapter of our economy; as the common man is apathetic to their preservation. Trees have no voice to enable them to be heard. They make their absence felt in devastating floods, erosion of valuable land by wind and water, diminishing fertility of fields on account of diversion of farm-yard manure to village hearths and in causing aridity, sand and dust storms, and consequent misery.

7. The State Government has formulated three Development Plans for soil conservation and afforestation in Kandaghat and Mohindergarh Districts, namely (i) Soil Conservation over Siwaliks (ii) Afforestation of Bhakra Dam Catchment Area and (iii) Desert Control in Mohindergarh, at a cost of Rs. 28·6 lacs for a period of five years. The Plans are being operated upon by the Forest Department from April, 1952; but the task is stupendous and needs continuity of operations for a number of years, inasmuch as unlike agricultural crops, trees take long to grow and develop. They impart the lesson of patience, perseverance and hard work, and this can be achieved only if the people rise with a determination and make a combined effort to build up new India.

•In Kandaghat District, 32 lac trenches of 10 feet and 5 feet have been dug over an area of 7,680 acres, 24,000 stone check-dams constructed over 5,583 acres and 4 feet wide paths, 79 miles in length, have been laid. An area of 4,722 acres has been afforested with trees of economic importance and 9,50,758 patches and 66,642 trenches sown with seed of suitable forest trees. 377 acres of cultivated land have been improved through embanking, terracing and levelling. Streams and ravines over a length of 15 miles have been treated and water course trained.

In Mohindergarh District, the work has been taken in hand for the check of the onward march of desert and fixation of sand dunes, for the first time this year, by the creation of wind breaks and shelter belts of trees along the border, in gaps and along Dohan River and the edges of cultivated fields.

The total area to be covered by these plans is 5,35,504 acres out of which 2,43,664 acres form catchment of Bhakra Dam, Ghaggar and Sirsa Rivers and Patiala *Naddi* whereas 2,41,840 acres are affected by Rajasthan Desert.

For the benefit of the local people in Parganas Raithan, Nali Dharti, Ghar and Ajmergarh, etc., of Tehsil Kandaghat, a forest road twenty miles in length, is being constructed at a cost of Rs. 5 lacs. The alignment has been completed and 3 feet wide track constructed.

In Patiala, Sangrur and Barnala Districts works have been taken in hand for the creation of regular plantation of Shisham and mulberry, *Kikar* and *Neem*, etc., over 12,000 acres of State Birs (scrub forest) within a period of five years. Large scale nurseries have been started for raising lacs of plants for planting in State forests and private areas. The total cost will be Rs. 10 lacs.

The Development of inland waters fisheries in the State has also been undertaken in order to tap the auxiliary food resources and to make available nutritious food to the consuming public. The plan costing Rs. 2·38 lacs aims at the production and procurement of 4½ lac lbs. of fish annually after five years.

The combined efforts of the people will ultimately reverse the process of retrogression. The destruction caused all round by soil erosion and sand dust storms will not only be ultimately completely checked; but the land now laid waste will again be made productive. The wheel of destiny will continue revolving to the great advantage of the nation. Our slogan should not be "Grow More Food" only, but "Grow More Trees" also.

INDIGENOUS CELLULOSIC RAW MATERIALS FOR THE PRODUCTION OF PULP, PAPER AND BOARD

PART XVII.—WRITING AND PRINTING PAPERS FROM CASTOR STEMS (*RICINUS COMMUNIS*, LINN)

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SUMMARY

Pilot plant experiments on the production of writing and printing papers from castor stems are described. The pulps were prepared by the sulphate process. Since castor stems are short-fibred, 30% bamboo pulp was blended with their pulp in the manufacture of papers. The papers were characterized by good formation and satisfactory strength properties. Two samples of papers are appended in this bulletin. One is a writing paper and the other is a printing paper.

INTRODUCTION

At the instance of the Indian Central Oilseeds Committee, New Delhi, an investigation has been undertaken at this Institute on the production of writing, printing and wrapping papers from castor stems (*Ricinus communis*, Linn). The results of the laboratory experiments on the production of chemical pulps from this raw material were described in an earlier publication[1]. In order to confirm these results, pilot plant trials were undertaken. The results of these experiments are described in this bulletin.

The cultivation of castor oil plant, the availability of the stems in this Country, and the proximate analysis of the stems have been described earlier[1] and, therefore, are not included here.

THE RAW MATERIAL

The castor stems (1 ton) of the annual plant were supplied by the Indian Central Oilseeds Committee from the Government Research Farm, Kalyanpur, Kanpur (Uttar Pradesh). These stems were free from roots and varied in length from 6 to 8 feet, and in diameter from 0·5 to 2·5 inches. The bark was about 1/16 inch in thickness.

Preliminary grinding experiments carried out in 1951 had indicated that stem of the perennial castor plant might yield suitable groundwood pulp for newsprint manufacture. In order to study the silvicultural aspect of the growth of this variety of the castor plant experimental plantations were raised in the Forest Research Institute, Estate in 1951 by the Central Silviculturist of this Institute. The thinnings (0·8 ton) after one year were also used for the trials recorded in this bulletin. The top portion of the stems were tender and had withered away. The sound portion varied in length from 6 to 8 feet, and in diameter from 0·5 to 2·3 inches. The bark was about 1/16 inch in thickness.

FIBRE DIMENSIONS

The fibre length of the annual variety from the Forest Research Institute, Estate and that of the perennial variety from Pushulok, Rishikesh, were given in the earlier publication[1]. The fibre length and diameter of the annual plant (with the bark removed) from Kalyanpur

(Kanpur) were determined in this investigation by the usual procedures followed in this laboratory. The sulphate pulp was used. The values for the fibre dimensions are given in Table I, fibre length distribution in Table II, and fibre diameter distribution in Table III.

TABLE I

Fibre dimensions

	Fibre length mm.	Fibre diameter mm.
Minimum	0·62	0·0105
Maximum	1·55	0·0385
Average	0·91	0·0210

The ratio of the average fibre length to diameter was 43 : 1.

TABLE II

Fibre length distribution

Length of the fibres mm.	Number of fibres	% of fibres
From 0·60 to 0·80	61	30·5
From 0·80 to 1·00	93	46·5
From 1·00 to 1·20	44	22·0
From 1·40 to 1·60	2	1·0
TOTAL	200	100·0

TABLE III

Fibre diameter distribution

Diameter of the fibres mm.	Number of fibres	% of fibres
From 0·01 to 0·02	85	42·5
From 0·02 to 0·03	108	54·0
From 0·03 to 0·04	7	3·5
TOTAL	200	100·0

PILOT PLANT TRIALS

The castor stems without the removal of the bark were crushed between the rollers of the bamboo crusher. The stems of over two inches in diameter were split in the bamboo splitter before crushing. The crushed material was cut into pieces of 1–2 inches in length and taken for digestion. About 700 lb. of the material were used for each digestion. The cooking was carried out by the sulphate process in a vertical stationary mild steel digester (100 cubic feet capacity) of the indirect heating – forced circulation type. Caustic soda and sodium sulphide were used in the ratio of 2 : 1. The pulp was washed thrice in the digester and finally in the potcher of 350 lb. capacity at 5% consistency. The bleaching was carried out with bleaching powder using about 75% of the total bleach requirements in the first stage and the remaining in the second stage. After the first stage of bleaching, the pulp was treated with 2% caustic soda at 70°C. for 1 hour. The digestion conditions, pulp yields and bleach consumption are given in Table IV. Two digestions were carried out according to the conditions recorded in Serial No. 1, Table IV, with nearly the same results.

The pulp was beaten in a beater of 350 lb. capacity at 5% consistency and mixed with 30% beaten bamboo pulp as the castor stem pulp was short-fibred. The requisite quantities of rosin size, alum, china clay and/or titanium dioxide, and ultramarine blue were added, and writing and printing papers were made on the Fourdrinier machine of the pilot plant of this Institute. The paper making machine was run at its maximum speed of 50 feet per minute. The strength properties of the papers are given in Table V.

Two samples of papers made in this investigation are appended in this bulletin. One is a writing paper and the other a printing paper.

DISCUSSION

The results recorded in Table IV indicate that pulps in satisfactory yields can be prepared from castor stems by carrying out the digestion under suitable conditions. Under the conditions studied, the digestion of the material with 24% chemicals (on the basis of the air-dry raw material) in 48 g./litre concentration for 5 hours at 162°C. for the first 1 hour and at 153°C. for the remaining period gives the best results. The results recorded in Table V also show that the pulp prepared under these conditions have the best strength properties compared with papers prepared from the pulps produced under other conditions. Since the castor stem is short-fibred, about 30% of a long-fibred pulp such as bamboo pulp is required to be added to the furnish. The papers were characterized by good formation and satisfactory whiteness.

The utility of castor stems for the manufacture of writing and printing papers depends mainly upon the price at which this material can be made available at the factory site.

CONCLUSIONS

1. Bleached pulps of good whiteness in 40·9–43·6% yield can be prepared from castor stems by the sulphate process. The pulps are, however, short-fibred.

2. White writing and printing papers of satisfactory formation and strength properties can be made from the castor stem pulps by blending with about 30% of a long-fibred pulp such as bamboo pulp.

3. The utility of castor stems for the manufacture of writing and printing papers depends mainly upon the price at which this material can be made available at the factory site.

Thanks are given to the Indian Central Oilseeds Committee, New Delhi, for supplying castor stems of the annual variety for these experiments.

REFERENCE

1. Bhat and Jaspal. *Indian Forest Leaflet*, No. 124 (1951).

TABLE IV.—PILOT PLANT TRIALS

Sulphate digestions of castor stems and pulp yields

1	2	3	4	5	6	7	8	9	10
Serial No.	Total chemicals* (NaOH : Na_2S=2 : 1)	Concentration of chemicals	Digestion temperature	Digestion period	Consumption of chemicals*	Unbleached pulp yield*	Bleach consumption of standard bleaching powder containing 35% available chlorine*	Bleached pulp yield*	REMARKS
	%	g./litre	°C.	hours	%	%	%	%	
1	24	48	162 for the first 2 hours and 153 for the remaining period	6	21·9	46·1	9·0	40·9	Castor stems from Kanpur were used. Well-cooked pulp was obtained. Another digestion under identical conditions was carried out with this raw material with similar results.
2	24	48	162 for the first 1 hour and 153 for the remaining period	6	22·5	..	9·2	43·6	Thinnings from the F.R.I. plantation of the perennial variety of castor plant were used. Well-cooked pulp was obtained.
3	24	48	Do.	5	23·4	48·2	6·8	43·1	Do.

* The % is expressed on the basis of the raw material (air-dry).

TABLE V.—PILOT

Strength properties of papers from pulps described in Table IV. Serial Nos. in this Table

1	2	3	4	5	6		7		8	
Serial No.	Freeness after the addition of size, etc.	Ream weight $17\frac{1}{2}'' \times 22\frac{1}{2}''$ —500	Basis weight*	Thickness	Tensile strength (Schopper)		Breaking length*		Stretch	
	c.c. (C.S.F.)	lb.	g./sq. metre	mils (1/1000 inch)	kg. breaking strain for 1 cm. width		metres		%	
					Machine direction	Cross direction	Machine direction	Cross direction	Machine direction	Cross direction
1*a*	110	18·8	61·6	3·05	4·13	1·85	6710	3000	2·0	4·0
1*b*	110	12·4	40·7	2·10	2·56	1·17	6290	2880	1·8	2·8
2	125	19·2	62·3	2·10	3·81	2·41	6120	3870	1·8	4·0
3	120	19·1	61·9	2·10	4·26	2·00	6880	3230	2·5	5·0

* In calculating this, oven-dry weight of the paper was used.

PLANT TRIALS

correspond to Serial Nos. in Table IV. The papers were conditioned at 65% R.H. and 72°F.

9		10		11	12	13		14
Tearing resistance (Marx-Elmendorf)		Tear factor*		Bursting strength (Ashcroft)	Burst factor*	Folding resistance (Schopper)		REMARKS
g.				lb./sq. inch		double folds		
Machine direction	Cross direction	Machine direction	Cross direction			Machine direction	Cross direction	
44	48	71·4	77·9	25·8	29·4	62	53	Writing paper. In its preparation, 30% bamboo pulp was added. Only 3% titanium dioxide was added as the loading material. Sample is appended in this bulletin.
27	30	66·3	73·7	15·8	27·3	32	20	The same stock as in Serial No. *1a* was used but thinner paper was made.
43	41	69·0	65·8	27·6	31·2	40	64	Printing paper. In its preparation, 30% bamboo pulp was used. China clay (10%) and titanium dioxide (2%) were added. Sample is appended in this bulletin.
41	45	66·2	72·7	30·4	34·5	170	80	Printing paper. The furnish was similar to that used in Serial No. 2 with respect to bamboo pulp and loading materials.

PRESERVATIVE TREATMENT OF GREEN BAMBOOS UNDER LOW PNEUMATIC PRESSURES

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INTRODUCTION

The preservative treatment of wood for protection against fungi and insects, as mentioned earlier[1], has been practised from time immemorial. But wood, in general, has to be dried to a moisture content of 10 to 12% before impregnation with preservatives, particularly of the oil type.

METHODS OF TREATMENT OF LIVING TREES AND GREEN TIMBER

The discovery in 1709[2] of the movement of sap in living trees opened a new field of attack for the introduction of chemicals soluble in water in the sap stream, for diverse purposes[3], viz.: (*a*) preserving non-durable woods, (*b*) staining wood for cabinet work, (*c*) artificial feeding of trees with nutritional elements, (*d*) pathological protection of forests and ornamental trees from insects and other diseases, (*e*) killing undesirable forest trees (silvicultural practice), (*f*) fire-protection of trees, and (*g*) treatment with water soluble, water dispersible, alcohol or acetone soluble synthetic resins, and other chemicals like zinc chloride, urea, urea-formaldehyde, phenol-formaldehyde, etc., which can impart better strength and/or dimensional stability to inferior woods. In 1873, Boucherie gave a new impetus to the problem by extending the treatment to freshly felled trees by the 'capping' method. Short descriptions[3b] of the methods employed hitherto for the treatment of green trees or poles are given below.

DRY PACKING METHOD

In this process, about 10 inches wide horizontal strip of bark and phloem is removed, preferably at the base of a tree, and the chemical either as dry powder or in a paste form is held using a water-proof wrapping material, such as an inner tube of a motor tyre. The preservative dissolves in the sap and is carried with it upwards along the stream.

BANDING METHOD

While in the older method a horizontal cut is made in the tree, in the new method a spiral kerf or groove is made approximately 1/2 inch deep into the wood, near the centre of a 10 inches wide, barked, spiral zone close to the base of a tree, the ends of the groove overlapping an inch or so. A 1/4 inch hole is next bored through the wood from one end of the groove, opening on the surface of the bole, 2 or 3 inches away and one end of a section of 1/4 inch rubber tubing is run all the way through it. A piece of stout rubber banding is stapled tightly to the tree over the spiral groove so that when in place, the band is stretched to about 1/2 again its original length. A container of preservative is fastened to the tree above the band, and the loose end of the rubber tube is connected to it. The solution is thus syphoned or run by gravity into the groove which mixes up with the sap and is carried with it into the tree.

BORE-HOLE METHOD

The method consists of boring a suitable number of holes at the base of a tree about an inch in diameter and 4–6 inches long, tangentially downwards through the sapwood, and

feeding these holes with preservative chemical solutions through a rubber tube attached to convenient containers held 4–5 feet up on the tree.

COLLAR METHOD

In this method, the bark of a tree is removed about 10 inches wide at the base, and a kerf or a groove about 1/2 inch deep and about 1 inch wide is made at the centre of the debarked portion, leaving an inch gap of clear wood between the ends of the groove. A suitable waterproof material is banded over this, over-lapping at the portion where the groove has been left out, and nailed on to the tree. Preservative solution is then poured through a small opening by stretching out the collar at the top. The preservative is absorbed, by the tree, as it dissolves in the moving sap.

STEPPING AND CAPPING METHOD

These two methods differ from the methods described above in that the tree is severed completely from its base. In the stepping method, the tree is placed in a suitable tank containing the preservative (with its butt end dipping in the solution) and is held upright supported against a neighbouring tree. The preservative is sucked up during the transpiration of the leaves. In the capping method, the crown is cut off and about 6 inches of bark is removed at the butt end. An old inner rubber tube of a motor tyre is tightly fixed at the debarked place and the tree is held either horizontally to the ground or made to lean on the ground with its butt end resting on a neighbouring tree about 8–10 feet above the ground. The free end of the tube which is held upright is then filled with the preservative which flows down its length under hydrostatic pressure. Where necessary the tube may be attached to a container for holding greater quantities of the preservative. In this method, the branches of the tree can be removed and the cut portions sealed off with asphalt roofing compound to prevent loss of preservative by leaking.

Several minor modifications of the above processes are also reported in the literature, for example Ludwig and Gewecke (German Patent 1943) allowed the preservative liquid to flow through from both ends to the centre of a pole, and some commercial concerns[3c] in the U.S.A. are reported to partially season large poles and use artificial pressures to inject the preservative.

While most of the methods mentioned above are quite ingenious and are applicable for the treatment of a limited number of trees for special purposes, they have never gained any popularity in actual wood preservation practices on a commercial scale, except perhaps the Boucherie process which generally extends over a period of a week or two depending upon the size and species of timber experimented upon. Quite a large number of poles and fence posts in green condition are said to have been successfully treated by the Boucherie process in France, the U.S.A., etc. Gäumann[5] reports that Swiss postal authorities successfully treated telegraph poles by the Boucherie process using copper sulpahte and obtained an average life of 22·5 years. In some areas the poles, however, gave an average life of only 14·5 years, the rejections being mainly due to attack by *Polyporous vaporarius*. In India, too, the M.S.M. Railway (now the Southern Railway) is said to have treated in 1865[6] green timber by this process at Palghat using copper sulphate and then converted them into sleepers for use on their lines. Very little information, however, seems to be available in the already extensive literature on the subject, on the application of these methods to the treatment of green bamboos, probably because bamboos are not available in those countries in which these methods were extensively tried.

DESCRIPTION AND OCCURRENCE OF BAMBOOS IN THE WORLD

Bamboos[7a] are tall, arborescent grasses belonging to the Bambuseae, a tribe of Gramineae. They grow either as shrubs or trees, very rarely herbs, culms erect or sometimes climbing, often tall, usually woody. They are primarily tropical in origin, thriving best in monsoon forests where they attain their maximum development and dwindle into under shrubs in temperate regions, and take the form of 'grasses' at high altitudes – 12,000 feet, almost to the snow line, in the South American Andes.

The bamboo belongs to four sub tribes : *Arundinarieae*, *Eubambuseae*, *Dendrocalameae*, and *Melocanneae*. There are about thirty genera and 550 species. Asia and South America account for 320 and 179 species respectively. About 136 species occur in India, 39 in Burma, 29 in Malaya and the Andamans, 9 in Japan, 30 in Philippines, 8 in New Guinea and a few in South America and Queensland. The more important genera of bamboos are *Arundinaria*, *Bambusa*, *Cephalostachyum*, *Dendrocalamus*, *Gigantochloa*, *Melocanna* and *Ochlandra*. Most of these are indigenous to India, Burma, South China and Malaya, and a few to South America. There is only one species of uncultivated bamboo, viz., *Arundinaria macrosperma* in the whole of North America and North Maxico. In Europe, there is not one native species but some have been introduced into Europe and Australia. Some species of bamboos are also grown as ornamental trees in Japan.

DISTRIBUTION OF BAMBOOS IN INDIA

"In[7b] India, the bamboos form rich belts of vegetation in the well-drained parts of the monsoon region at the foot of the Himalayas, and rise up to about 12,000 feet, almost to the snow line. Their distribution is quite dense in Burma, Assam and Bengal, the north-eastern Himalayas, the Western Ghats, Ceylon and Andamans. The principal genera of bamboos met with in India are – *Arundinaria*, *Bambusa*, *Cephalostachyum*, *Dendrocalamus*, *Gigantochloa*, *Melocanna* and *Ochlandra*. To mention the distribution of some of the important species – *Bambusa arundinacea* is found in Orissa, Assam, Eastern Bengal, South and Western India. *Bambusa vulgaris* in Assam and Burma ; *Bambusa tulda* and *Bambusa balcooa* in Bengal ; *Arundinaria aristata* in Eastern Himalayas and *A. wightiana* in the Nilgiris ; *Bambusa polymorpha* in the upper mixed forests of Eastern Bengal and Assam ; *Pseudostachyum polymorphum* in the valleys of Eastern Himalayas, Assam, Upper Burma and Sikkim. *Dendrocalamus strictus* in deciduous forests throughout India. The chief species in Northern Bengal and Assam is *Dendrocalamus hamiltonii* ; in Eastern Bengal and Chittagong the most common kind is *Melocanna bambusoides* ; *Cephalostachyum pergracile* is quite common in the moist parts of Bengal and Burma and also in Assam ; *Oxytenanthera thwaitesii* is common in Western Ghats and Ceylon ; *O. monostigma* common in Western Ghats from Konkan to Annamalai hills ; *O. bourdillonii* is a common species in Travancore between 2,000–4,000 feet *Teinostachyum wightii* – found on the slopes of Western Ghat ; *Ochlandra rheedii* is common in Malabar and Travancore and *O. travancorica* is spread in the mountains of South India".

Bamboos vary in size and yield per acre. The size depends upon the species, locality of growth, etc. For example[8] *Dendrocalamus giganteus* gives culms 120 feet long and 8–10 inches in diameter and *Arundinaria densifolia* gives culms hardly 3 feet long and 1/3 inch in diameter. Again while some bamboos like *Dendrocalamus strictus* are almost solid especially in the dry places, the rest are hollow, with the wall-size varying from 1/4–1/3 inch. Generally speaking it may be taken that the yield per acre is about 1 ton per year or 300 in number, the felling cycle being 3 seasons.

DIVERSE USES OF BAMBOOS

The bamboo is a very useful material, *cf.*, plates 7–16. It is generally used for weaving baskets, house-hold articles like sieves, winnows, and chicks. It is used as a base on which

mud roofs are built, for construction of small bridges on canals and rivulets. Recent experiments in China, Japan and India reveal that it can be used for re-inforcing cement concrete in place of steel and also in re-inforcing mud walls. The first recorded use of bamboo rods in place of steel rods was in concrete piles, in China in 1919, by the Szechuan-Hankow Railway[9]. A 50 per cent saving in cost was effected from dollars 28 to 14 per mile. Bamboo reinforced concrete was next used in China for building roads. Reference is also made in engineering literature to a bamboo reinforced concrete hospital floor installed at Canton, China. Beautiful looking pale fencing and corrugated roofs can be built using split bamboos. In the villages it is used extensively for house building, as rafters and purlins over which palmyra leaves and thatch grasses are used for roofing purposes. In the towns and cities, it is used very extensively for scaffolding work, house-hold aerial posts, and umbrella rods. It is the common Policeman's baton or scout's staff. In the field of agriculture it is used to give support against winds to sugarcane, plantain tree and betel vines, and as poles for "Aetham" or "Picottah", a device for taking out water from canals and wells for irrigation purposes. Mention should also be made of the recent development in the use of bamboo for making boards called "Ply-bamboo"[10], using various types of glues and high pressures and temperatures to get compact and strong boards. This pioneer work of China is being followed up at the Forest Research Institute, Dehra Dun[11] with suitable modifications demanded by local conditions. Paper making is one of the chief commercial uses to which bamboo is put in this country. In the harbours, it is used, in bundles, as floating fenders and it is also generally used as rafts for the transport of logs in rivers and canals. The Defence Department uses bamboos for tent posts and flagstaffs. It is said that in the olden days bamboos were used for distribution of drinking water in place of the modern metal pipes. The bamboo is otherwise also a useful material; its leaves are used as medicinal feed for the cattle after calfing, the branches and leaves serve as normal fodder for elephants, the rhizomes and the seeds are pickled and cooked respectively for human consumption. The bamboo wax is used as a base for shoe polishes and carbon paper in place of carnaba wax, and recently a diesel fuel[16] oil is reported to have been manufactured from bamboo. Bamboo fibres are also carefully carbonized and used as filaments for carbon bulbs. These are generally used more for generation of heat than light.

STRENGTH OF BAMBOOS

The bamboo is structurally a strong material. It has long fibres with considerable tensile strength. Weight for weight it is even stronger than timbers like sal and teak as may be seen from the following[12] Table :

Species	Strength of Bamboos in lb./sq. in.			
	Moisture content	Modulus of rupture	Modulus of elasticity	Maximum crushing stress
Dendrocalamus strictus ..	58	13600	2220	6000
	12	18600	2560	8850
Bamboosa balcooa	22	14400	2420	6400
Bamboosa nutans	12	9400	1580	..
Bamboosa tulda	12	12500	1750	..
Tectona grandis (teak) ..	52	11400	1670	5850
	12	151000	1880	8800
Shorea robusta (sal)	60	13600	1960	7050
	12	18700	2300	9100

But as bamboos do not grow in sizes suitable for heavy constructional work like piles, beams, transmission poles, etc., they are not normally used for such purposes. The outer layers of bamboo are stronger than the inner layers. Bäumann[11] gives the following values :

	Outer layers	Inner layers
Bending strength lb./sq. in. ..	36,000	13,500
Tensile strength lb./sq. in. ..	44,000 to 47,000	21,000 to 23,000

Work on bamboo reinforcement was carried out in the U.S.A., Germany and Italy. In the U.S.A., tests showed that the bamboo reinforced concrete beams gave a strength of 20,000 lb./sq. in., in tension while steel reinforced beam 70,000 lb./sq. in.

As regards the variation of the strength of bamboo with its age, systematic investigations have been initiated in the Timber Mechanics Branch of this Institute and the present indications are that the strength rapidly increases in one to two seasons and reaches practically the maximum by about 3 seasons.

SEASONING OF BAMBOOS

Bamboos are best dried without serious damage by the air seasoning method, under cover, for a period of two to three months. Kiln seasoning under control conditions can be carried out successfully in about 2 to 3 weeks, but this process is considered uneconomical. The seasoning of bamboos is expected to be as satisfactory as of timbers of corresponding density. It is to be noted that the outer memberane of the bamboos and to some extent the inner membrane also are quite refractory and cause splitting of the bamboo under conditions leading to rapid drying.

NATURAL DURABILITY OF INDIAN BAMBOOS

Bamboos are easily susceptible to insect attack and moderately to fungal decay, *cf.*, plate 6, the deterioration due to "Lictus" (powder post beetle) attack being the most severe and extensive. In the graveyard tests, *cf.*, plate No. 5, at the Forest Research Institute, *Dendrocalamus strictus*, *Bambusa tulda* and *Bambusa balcooa* gave an average life of 22, 32 and 41 months respectively ; under cover they may be expected to last from 4 to 5 years depending upon severity of incidence of attack. In the sea waters, the bamboo is generally destroyed by marine organisms in less than 24 months. It is best stored under sweet water.

In recent work at Puerto Rico the incidence of attack, particularly due to *Dinoderus minutus*, is found to be directly proportional to the starch content. The relative susceptibility of 1 year old culms of eleven species varied from 44% in *B. vulgaris var. vittata* to 0·3% in *B. textiles*. On the whole, susceptibility increased from the base to the top of a culm. It was found that much damage could be avoided by harvesting culms of *B. vulgaris* in the third year or older, *B. tulda* and *B. tuldoides* in the second year or older, and *Dendrocalamus strictus* and *Sinocalamus oldhami* during the irlst year of growth. Harvesting in August–December results in less infestation than harvesting in February–May. From the data obtained in the studies it does not appear that infestation can be avoided by harvesting

according to the phases of the moon. Drying the felled culms at clump gave 90% control of infestation, best results being obtained in moist, hot weather, when the cut culms could be kept alive for a month or more, during which period most of the starch was depleted. Shed-curing for at least 8 weeks, thereafter, made culms even less susceptible. Infestation was reduced by 94% by placing the freshly cut culms in water and keeping them for 8 weeks, but this treatment stained the wood and made it light in weight and brittle.

STATISTICS ON THE AVAILABILITY OF BAMBOOS IN INDIA

The statistics[14] on the availability of bamboos in all the states of India are not complete. Table No. 6 gives the figures, so far obtained of bamboos taken out of forest areas and does not include figures of bamboos taken out of non-forest and agricultural areas. These show that about 9 lac tons of bamboos were taken out during 1948–49. It may be safely taken that about 15 lac tons of bamboos may be available if systemetic exploitation is carried out in all the states, the forest and non-forest areas being included for the purpose. Out of this, about 2 lac tons are being utilized by the paper industry alone. This figure is likely to increase by 50–75% in the next 5 years, thus leaving a meagre figure of 10–12 lac tons for the rest of the industries. A moderate house requires about a ton of bamboo for its construction. At the rate of building 25 lacs of houses a year, our housing problem can be solved in about 5–6 years. Therefore, the present out turn of bamboos should be very considerably increased by raising plantations in all forest areas and also on canal and river banks. Even then the full demand of bamboos for original structures cannot be met unless the present replacement cycle of 2–3 years for the old structures is increased. This can be done only by preserving bamboos on a mass scale and thus increasing their service life by 7–10 times their untreated life.

SERVICE DATA OF TREATED BAMBOOS (AIR-DRIED)

As mentioned earlier, very little published information is available on the preservative treatment of bamboos conducted in a systematic way. In the early (1925–42) experiments conducted in this Branch dried bamboos were impregnated with both water soluble preservatives of the fixed type, and creosote-fuel-oil mixtures (50 : 50 by weight). Table No. 2 shows these results for round bamboos. It will be seen from the results that the absorptions have been anything but satisfactory even when pressure processes were employed ; even with an absorption of 4–5 lb. per cu. ft. of creosote mixture most of the specimens were attacked by fungi and termites in less than 8 years service. This shows that the penetration of the preservative was quite poor. On the other hand dried bamboos split before pressure impregnation with ASCU, have been in the yard for over 14 years and they are still in a satisfactory condition. Unfortunately, data on the absorption of the preservative and corresponding treatment with creosote are not available.

SUMMARY OF PAST WORK CARRIED OUT ON THE TREATMENT OF GREEN BAMBOOS BY THE BOUCHERIE METHOD

During the war the preservative treatment of bamboos for the army became very urgent and since there was not time to be lost in drying the bamboos, treatment in green condition was undertaken. Results of these investigations are reported in two[15a & b] publications of this Institute. These indicate that for good protection against termites, fungi and borers, treatment by the Boucherie process (capping with old bicycle tubes) extending over 5–6 days is necessary. Similar experiments appear to have been carried out in Puerto Rico[13] using copper sulphate with satisfactory results. It is also reported that impregnation with synthetic resins made the bamboo immune to attack and imparted to it other desirable qualities.

TREATMENT OF GREEN BAMBOOS BY MODIFIED BOUCHERIE METHOD USING PNEUMATIC PRESSURE

It will be seen from the above that interesting as they are the above experiments are frowned upon because they are commercially inadequate. An attempt was, therefore, made in recent months with the object of simplifying the method of treatment so as to make it commercially applicable for large scale treatment of bamboos in the forests and to cut down the period of treatment from a few days to a few hours. For this purpose the capping method was modified using 10–15 lb. pressure on the preservative contained in a closed vessel, and it would appear that this method is the first of its kind used for the treatment of green bamboos at any rate. These air pressures are intended to ensure better and quicker penetration, and absorption of the preservative, and particularly to eliminate the unwieldy method of application of hydrostatic pressure involving the raising of the log or bamboo or the reservoir several feet high above the ground. Details of these experiments are given below.

The method of treatment of green bamboos is illustrated in plates 1, 2, 3 and 4. Plate 1 illustrates the case where a bamboo over 25 feet long or a log 15–20 feet long is fixed to the apparatus at 'C' either through a pressure rubber tube 'A' attached to the bamboo or a special clamp 'B' fixed to the log. In either case instead of the usual butt end, the thin end of the bamboo or log is attached to the apparatus since this has been found more convenient not only in making the connection easy and quick but also allowing the use of rubber tubes of small diameters, which are naturally cheap. For treating individual bamboos, as for example flagstaffs, aerial posts, badminton posts, etc., the apparatus in plates 2 and 3 are quite suitable. In plate 2, a container about 1–2 litres (old Dunlop or Slanzenger tennis ball tins) capacity is used as the reservoir. To the bottom end of the tin, a small metal tube about an inch in diameter is soldered. At the top, a metal plate is soldered to which are attached a bicycle valve and a pressure gauge which reads up to 30–50 lb. air pressures. A rubber tube is then fixed to the metal tube which serves to connect the top end of a bamboo to the reservoir. The connections of the rubber tube to the apparatus and the bamboo can be made firm by winding galvanized wire over the joints once or twice and twisting the ends with pliers or by means of any other suitable arrangement. After attaching the bamboo, the pressure gauge is taken out; the preservative is poured through the hole where the pressure gauge is fixed till the tin is filled to 3/4th its capacity. Filling is facilitated by removal of the valve, through which displaced air escapes. The valve and the pressure gauge are then replaced and air of 10–15 lb. is pumped in. It will be seen that in most cases within 2–3 minutes after pumping in the air, drops of sap start trickling down the butt end of the bamboo. After about 5 minutes the preservative starts flowing, mixed with the sap. The preservative actually enters the wall of the bamboo through the fine pores in the wall of the bamboo from the end which is fixed to the apparatus. It is through these fine pores the living bamboo takes in water from the soil through the root sytsem. As the preservative flows down the bamboo it also fills in the septa (internodal partitions) at each node, and where there are branches even these get thoroughly treated. In fact even if the leaves are cut, one could see the preservative oozing out of the cut end of the leaves. Such is nature's complicated system of passage of water and food materials in a bamboo. As time passes, one could see the preservative dripping at the butt end along with sap juices. This liquid deepens in colour as more and more of the preservative comes out. The treatment is completed when the concentration of the effluent preservative, which can be judged by its colour in case of coloured liquids, is nearly the same as that contained in the reservoir. Thus it will be seen that in this case it is no longer necessary to incise the bamboo as was done in the earlier experiments reported in Bulletin No. 137 of 1947. In plate 4, a hose pipe of a suitable size is used; the open end being closed, after fixing the bamboo at the other end and pouring in the preservative, with a rubber stopper to which

Bamboo Treating Apparatus

PLATE 1.

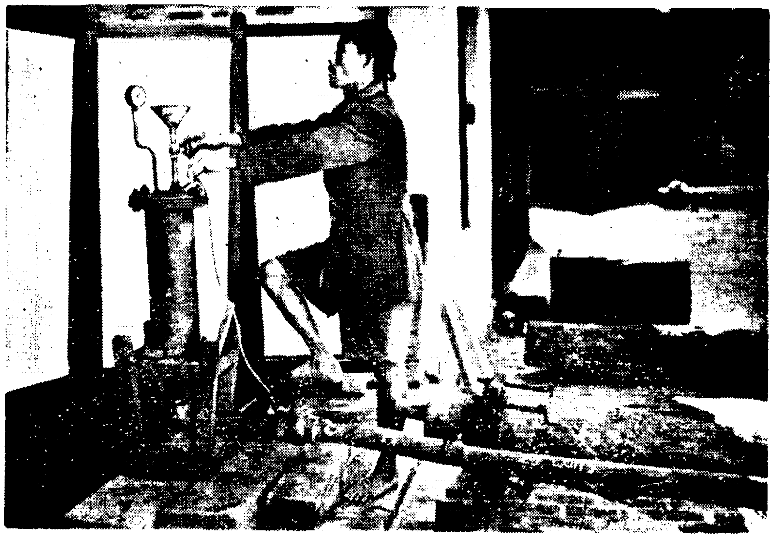


PLATE 2.

PLATE 3.

PLATE 4.

PLATE 5.—Graveyard for conducting durability tests on bamboos in the open at F.R.I.

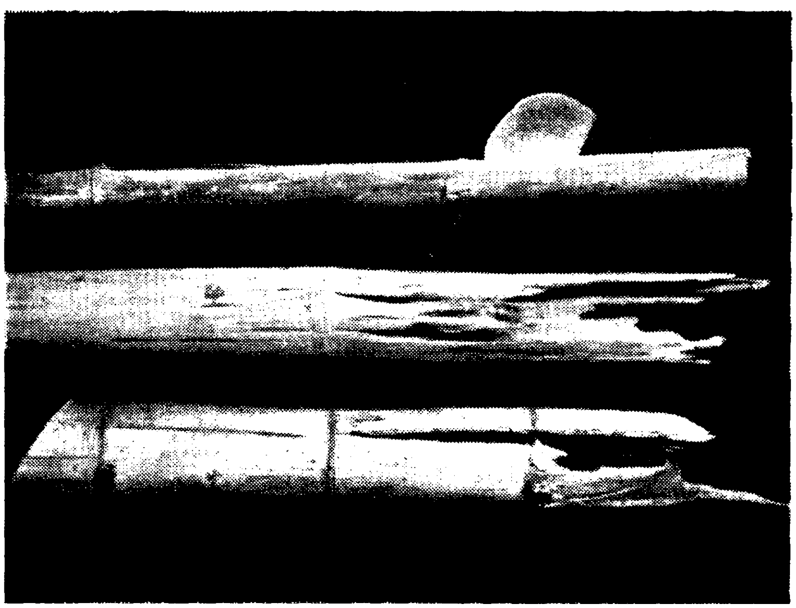


PLATE 6.—Untreated bamboo specimens attacked by fungi, termites and borers (left to right) in the tests at F.R.I.

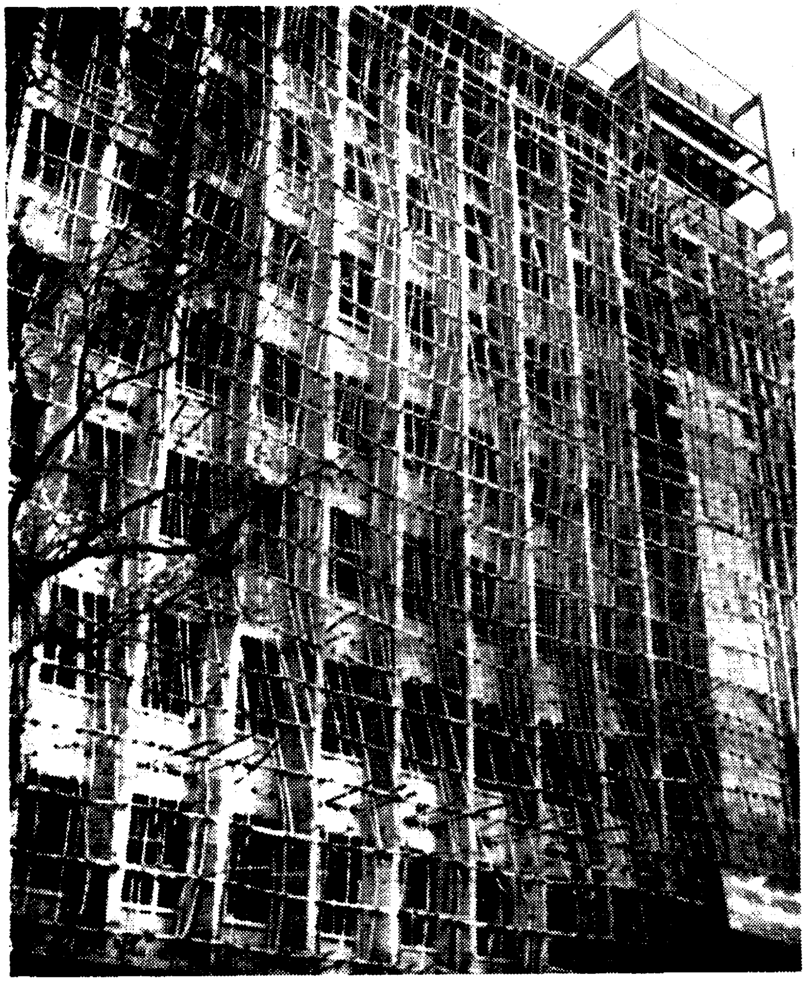


PLATE 7.—Bamboo scaffolding work in Calcutta.

PLATE 8. Fire proofed bamboos as rafters at F.R.I.

PLATE 9(*a*).—Before erection.

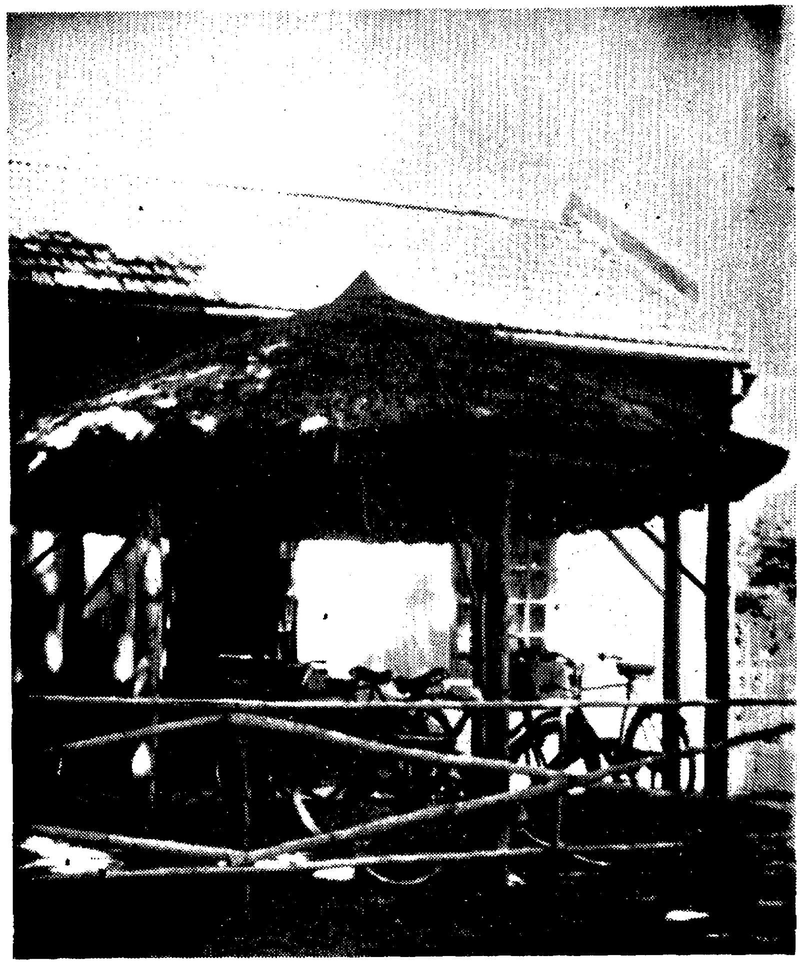


PLATE 9(*b*).—After erection.

PLATES 9(*a*) and (*b*).—Treated timber, bamboos and thatch grass are used to construct the above shed for service tests at F.R.I.

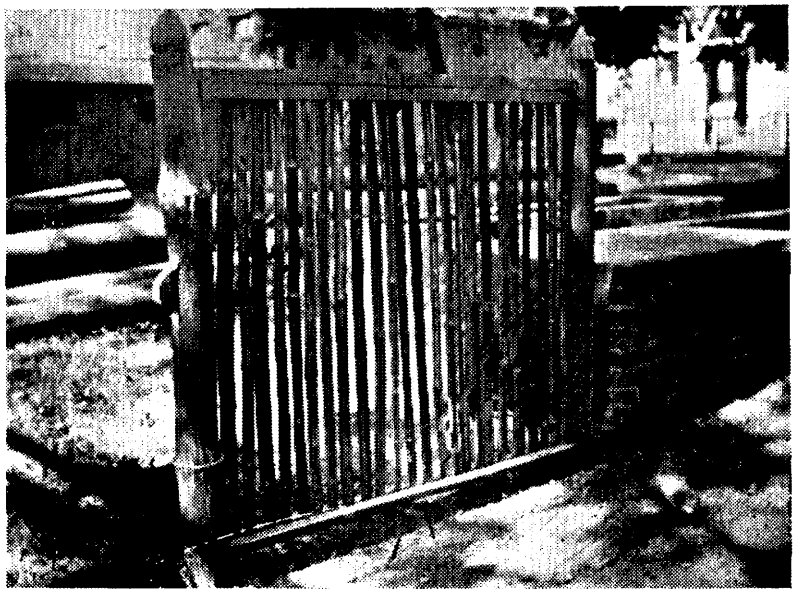


PLATE 10.—Treated split bamboo pale fencing at F.R.I.

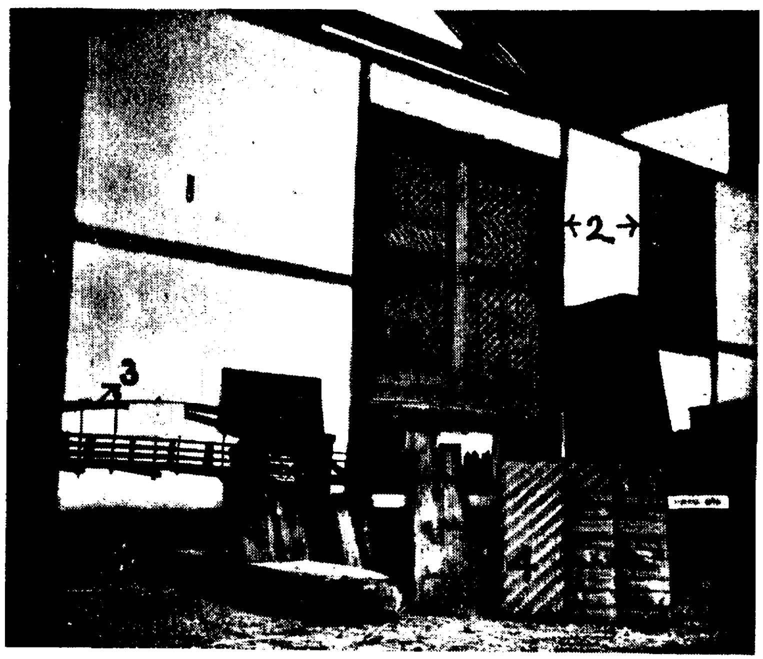


PLATE 11.

(1) Treated bamboo reinforced mud wall.
(2) Treated bamboo mat used for door and window panels.
(3) Model of a treated bridge constructed of laminated timber.
(4) Treated banana bark makes good partition wall.
(5) Treated shingles can also be dyed.

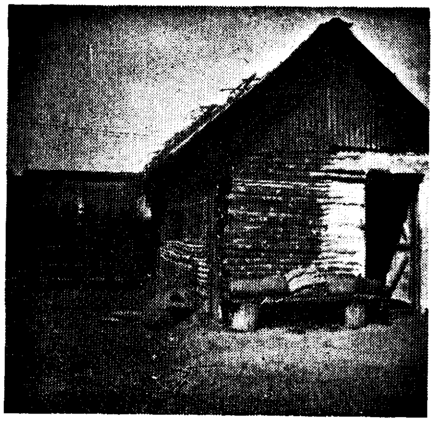


PLATE 12.
ASCU treated split bamboo walls at Bhadrawati after 14 years service.

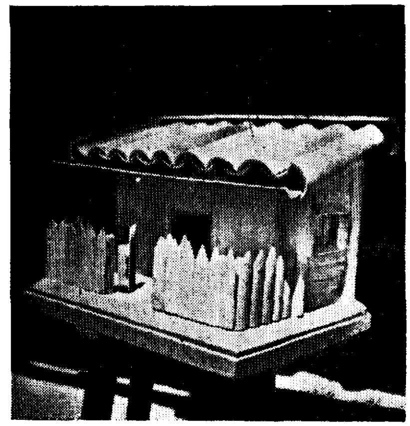


PLATE 13.
Model of a house using corrugated bamboo roof.

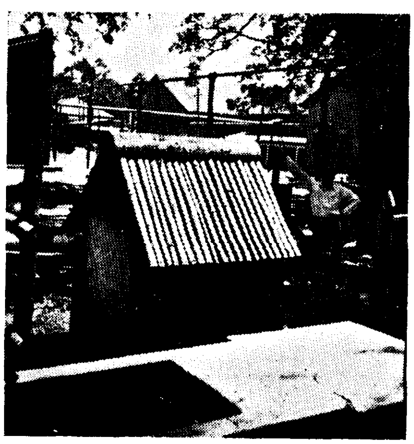
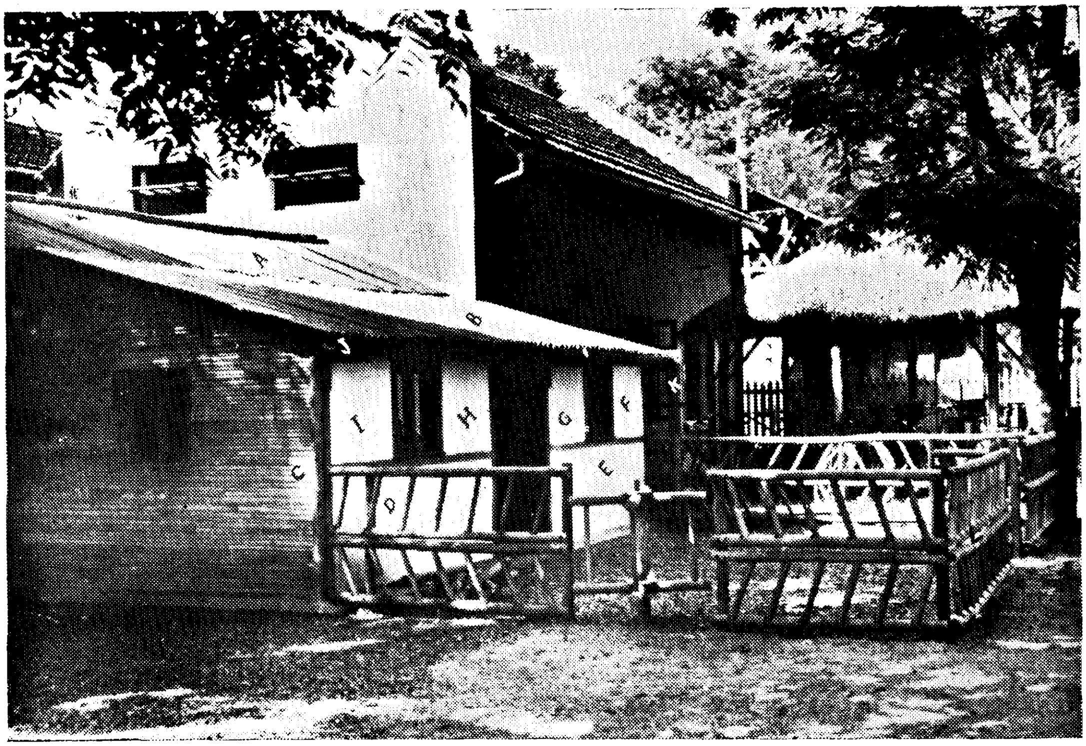
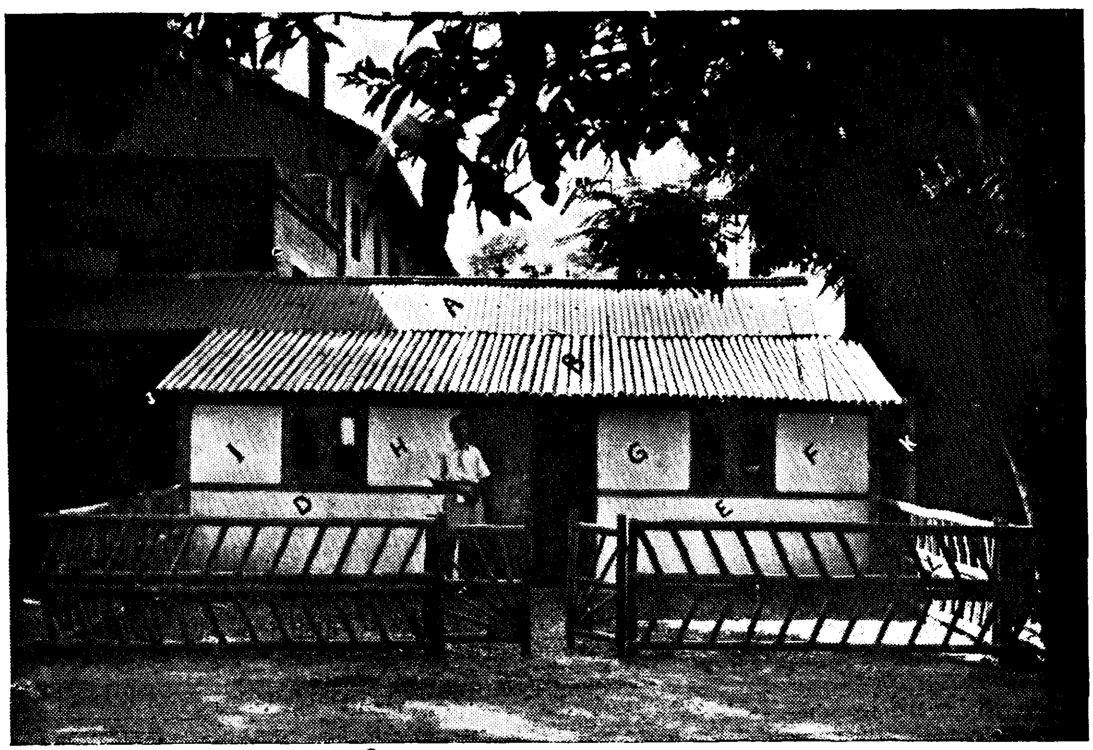


PLATE 14.
Corrugated treated bamboo roof and treated bamboo reinforced mud and cement walls undergoing service tests at F.R.I.

PLATE 15.—Model of a house using treated bamboo reinforced mud walls and roof of thatch grass treated against decay, insect attack and accidental fires.

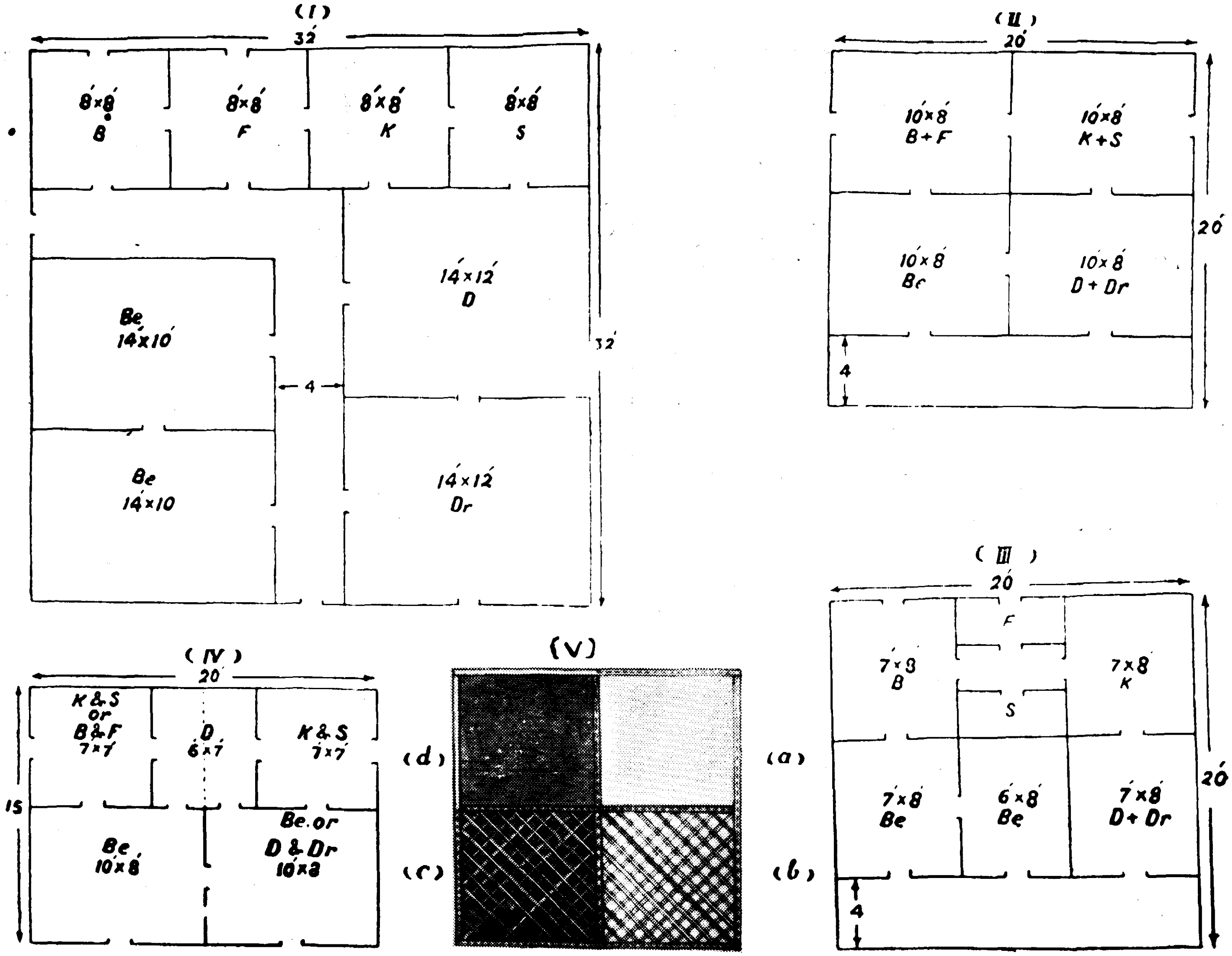
PLATE 16.—TREATED BAMBOO HOUSE UNDERGOING SERVICE TESTS AT FOREST RESEARCH INSTITUTE, DEHRA DUN.





(A) Galvanized corrugated iron roof, (B) Treated corrugated bamboo roof, (C) Treated half split bamboo strip wall, (D) Treated bamboo reinforced mud-wall plastered with stabilized earth mixed with treated saw-dust, (E) Treated bomboo reinforced cement concrete wall, (F) Same as 'D' but plastered with cement mortar, (G) Same as 'D' but plastered with lime mortar, (H) Treated bamboo reinforced mud-wall plastered with stabilized earth, (I) Treated bamboo reinforced mud-wall plastered with treated saw-dust, (J) Half split bamboo drainage, (K) Treated bamboo gutter pipe, (L) Treated bamboo fence including gate and turn-pike.

FIG. 1—Diagram showing accommodation in four types of houses (I to IV) using bamboo (treated) reinforced mud or cement concrete walls and treated thatch grass roof. In No. V details of the construction of the wall are shown.



Legend :—Be – Bed room, B – Bath room, D – Dining room, Dr – Drawing room, F – Fuel room, K – Kitchen, S – Store room, a – Framework, b – Bamboo latticed work in 'a', c – Filling of 'b' with a mixture of mud and treated grass bits, d – Plastering of 'b' with cement concrete or 'c' with mud.

Note—In addition to mud plastering, exposed walls (to rain) may be further covered with a thin layer of cement concrete or treated saw-dust mixed with stabilized soil.

a bicycle or preferably a motor tube valve is fixed. In the latter case the pressure inside the system can be easily read by means of the usual pencil pressure gauge which motorists use. In plate 4, is shown how more than one bamboo, say four, may be treated simultaneously. Here a 4 gallon petrol tin is used. If instead of this a 45 gallon drum is fixed with suitable arrangements for fixing the bamboo, about 50–100 bamboos can be treated simultaneously. In all these cases, the preservative which has flown out at the butt end can be re-used after bringing up the concentration of the preservative to its original strength.

RESULTS AND DISCUSSION

The results of these experiments are given in Table Nos. 2 and 3. It will be seen from Table No. 2 that satisfactory absorption of zinc chloride is obtained in the case of the two species of bamboo – *Bambusa polymorpha* and *Bambusa nutans* tried. As indicated in the earlier publication an absorption of 0·5 lb. of zinc chloride per cubic foot of bamboo is considered sufficient for the protection of bamboo against decay and insect attack when used in the open, provided it is properly fixed. A minimum period of treatment and concentration of the preservative, can be varied depending upon the length and species of the bamboo used, after a few preliminary experiments. For use in the buildings, especially for reinforcing cement concrete or mud walls an absorption of 0·3 lb. may be considered sufficient, that is, treatment should be continued for a minimum period of 2 hours and for prophylactic purposes 0·25–0·5 hours is sufficient. It will also be seen from experiment No. 15 that the absorption of the preservative in the septa is much more than that in the wall. This is because the septa contain comparatively very much bigger pores which get completely filled with the preservative. The function of sodium dichromate in this low concentration is to give colour to the solution and to protect the apparatus, especially the valves, from corrosion.

Table No. 3 gives elaborate data on the treatment of bamboos of the two species – *Bambusa polymorpha* and *Dendrocalamus strictus*. As complete a data as possible, on the age, the time taken for the first drop of sap and the preservative to flow out, the quantity of the preservative flowed out and that retained in the bamboo at the end of treating period, the sizes of the bamboo, and in some cases the quantity of the preservative by chemical analysis are given. Regarding the first few bamboos which were taken out from scattered clumps in the New Forest area and used for obtaining preliminary data the age is not known. But for the rest of the experiments only bamboos of known ages were used. Five preservatives have been tried in these experiments :—a – Boliden salts, b – ASCU, c – Copper-chrome-boric composition, d – Chromated zinc chloride, e – Fire-proof-cum-antiseptic composition. Except the last two, the others are patented compositions. All these preservatives other than d are of the fixed, water soluble type, i.e., they can be used for the treatment of timber, bamboo and grasses for outside use without fear of the preservative being leached out by rain or water in the soil, rivers, and canals. It will be seen from these experiments that in some bamboos the treatment has been very poor due to resistance to the flow of the preservative. The bamboo, like timber, is a naturally occurring bio-chemical product and its growth and structure are influenced by such varying factors like soil, environment, altitude and moisture. Thus it is not uncommon to note considerable differences in the physico-chemical properties of different species of trees or bamboos growing in the same area, same species growing in different places, and even at different points of the same tree or bamboo growing in any place. It is now proposed to investigate in details, the cause of the obstruction to the flow of the preservative. With the increase in the age of the bamboo and decrease in the sap content, it is likely that structural deformations may be taking place causing both plugging in by chemicals and mechanical compression of the pores. To this may be added, another serious trouble which is caused by the entrance of air into these pores. Air bubbles, it may be mentioned, cause severe obstruction

to the flow of liquids, particularly in fine capillaries, and very high pressures are required to eliminate them. As the bamboo normally attains sufficient strength for all practical purposes in 3 seasons, it is proposed to restrict the experiment to those age classes. This may be confirmed after further work in this direction and completion of the tests now under way in the Timber Mechanics Branch correlating age of bamboo of different species with their strength.

It is now proposed to make a survey of the treatment of green bamboos available in all the states of India, in great detail, and also put up a semi-commercial treating plant at the Forest Research Institute, Dehra Dun, which can take up treatment of 50–100 bamboos at a time, and also develop simple field tests for the determination of the concentration of the dripping solution so as to enable non-technical men to fix the duration of the treatment. This will considerably help the introduction of this treatment on a mass scale in the forests on a cottage industry basis.

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TABLE NO. 1

Results on the service life of treated and untreated Bamboos (air-dry)

Serial No.	Species	No. tested	Preservative used and its % conc.	Process of treatment	Absorption in lbs./cu. ft.	Date of laying	Date of inspection	Condition at the time of inspection: Treated life in months	Condition at the time of inspection: Untreated life in months	REMARKS
1	. .	6	Wolman salts 2·0	Fullcell :— Vac. 24" ; 30 mts. Pres. 175 ; 5 mts. Vac. 20" ; 10 mts.	. .	19–11–29	3–10–31	Dwf : 20	Dwf : 17	
2	. .	6	„	Cold soaking for 24 hrs.	. .	„	„	Dwf : 20	Dwf : 17	
3	. .	3	Creosote : fuel oil mixture (50 : 50)	Pressure 175 for 30 mts.	0·047 per bamboo	8–7–35	13–11–45	Dw : 120	Dw : 17	3′ long round.
4	. .	3	„	„	„	„	„	Dw : 93	Dw : 17	3′ long split.
5	. .	3	„	Heating at 80°C. for 15 mts. and cooling 3 hrs.	0·021	„	„	Dw : 62	Dw : 17	3′ long round.
6	. .	3	„	„	0·026	„	„	Dw : 57	Dw : 17	3′ long split.
7	*Dendrocalamus strictus*	11	„	Heating at 91°C. for 2 hrs. and cooling 18 hrs.	6·3	15–3–40	14–12–50	Dwf : 95	Dwf : 20	Bamboos 1·5′ long.
8	„	11	„	Cold soaking for 48 hrs.	2·1	„	„	Dwf : 46	Dwf : 20	„
9	*Bambusa tulda*	3	Black varnish (100%)	Brush painting 2 coats	. .	2–4–41	5–12–44	Dw : 28	Df : 32	
10	*Dendrocalamus strictus* (green)	3	„	„	. .	„	„	Df : 28	Df : 22	
11	„	3	Black varnish and fuel oil (50 : 50)	„	. .	„	„	Df : 29	Df : 22	
12	*Bambusa tulda*	3	„	„	. .	„	„	Df : 37	Df : 32	

(*contd.*)

TABLE NO. 1—(*concld.*)

Results on the service life of treated and untreated Bamboos (air-dry)

Serial No.	Species	No. tested	Preservative used and its % conc.	Process of treatment	Absorption in lbs./cu. ft.	Date of laying	Date of inspection	Condition at the time of inspection		REMARKS
								Treated life in months	Untreated life in months	
13	*Bambusa balcooa*	13	Creosote and fuel oil mixture (50 : 50)	Heating at 95°C. for 6 hrs. and cooling 16 hrs.	4·4	9–10–42	6–2–53	Swf: 5 Mwf: 6 Bf: 1 Df: 1: 99	Dwf: 41	Poles 14′ long and about 3″ diameter.
14	,,	7	,,	Dipping in oil at 95°C. for 2 hrs.	1·7	,,	,,	Dwf: 52	Dwf: 41	,,
15	,,	6	,,	Fullcell :— Vac. 25″ for 0·5 hr. Pres. 150 lbs. for 1 hr. Vac. 25″ for 0·3 hr.	4·9	,,	,,	Swf	Dwf: 41	,,
16	,,	6	,,	Lowry :— Pres. 150 lbs. for 1 hr. Vac. 25″ for 0·3 hr.	4·3	,,	,,	Swf: 3 Mwf: 1 Bwf: 1 Df: 1:112	Dwf: 41	,,
17	*Dendrocalamus strictus*	8	,,	Fullcell :— Vac. 20″ for 0·9 hr. Pres. 175 lbs. for 1·5 hrs. Vac. 20″ for 0·3 hr.	..	19–3–43	10–4–53	N: 1 Sw: 1 Sf: 1 Df: 5:105	..	Poles 8′ long and 2″ diameter.
18	,,	8	,,	Heating at 95°C. for 4 hrs. and cooling 18 hrs.	..	,,	,,	Sf: 1 Df: 7: 92		
19	*Bambusaarundenacea*	8	,,	Fullcell :— Vac. 20″ for 0·9 hr. Pres. 175 lbs. for 1·5 hrs. Vac. 20″ for 0·3 hr.	..	,,	13–3–53	Dwf: 88	..	Poles 8′ long and 2″ diameter.
20	,,	8	,,	Heating at 95°C. for 4 hrs. and cooling 18 hrs.	..	,,	,,	Dwf: 70	..	,,

N = sound ; S = slight ; D = destroyed ; F = fungus ; W = termites.

TABLE No. 2

Results of treatment of *Bambusa polymorpha* and *nutans* with 16 and 8 per cent of zinc chloride to which 2 per cent sodium dichromate† was added in each case. The bamboos were approximately 20 feet long and chemical analysis of treated bamboos were made on specimens taken at 2 feet from each end on inner and outer walls.

Serial No.	Percentage concentration of zinc chloride used for treatment	Absorption of zinc chloride in lb./cu. ft.				Duration of treatment in hours	Species of Bamboo used
		Entering End		Dripping End			
		Inner	Outer	Inner	Outer		
1	16·3	1·34	1·23	0·92	0·78	3·0	*Bambusa polymorpha*
2	,,	0·92	0·47	0·62	0·60	2·0	,,
3	,,	0·60	0·75	0·32	0·29	0·5	,,
4	,,	0·25	0·24	0·15	0·18	0·25	,,
5	7·5	0·72	0·61	0·89	0·59	6·0	*Bambusa nutans*
6	,,	0·97	0·70	0·89	0·40	5·0	,,
7	,,	0·62	0·55	0·62	0·85	4·0	,,
8	,,	0·28	0·42	0·44	0·39	3·0	,,
9	,,	0·49	0·31	0·18	0·17	2·0	,,
10	,,	0·28	0·38	0·22	0·30	1·0	,,
11	,,	0·55	0·65	0·46	0·57	6·0	,,
12	,,	0·74	0·60	0·35	0·46	5·0	,,
13	,,	0·66	0·42	0·41	0·39	4·0	,,
14	,,	0·38	0·57	0·38	0·38	3·0	,,
15*	,,	0·45	0·68	0·40	0·37	2·0	,,
16	,,	0·41	0·35	0·24	0·30	0·5	,,

* Absorption of zinc chloride in the septa is 0·59 lb./cu. ft.

† This small quantity of sodium dichromate is added to protect the apparatus from corrosion due to zinc chloride.

TABLE NO. 3.—Results of treatment of *Bambusa polymorpha* and *Dendrocalamus strictus*
(*c*) Zinc chloride to which 2% of Sodium dichromate was added

Serial No.	Species of bamboos treated	Approximate age of bamboo in months	Preservative used and its % conc. in water		Pneumatic pressure applied on the preservative solution in lbs. and period of treatment in hours		Dripping of sap and preservative at butt end in minutes after start		Valume of sap and preservative flowed out in c.c.	
			Preservative	Conc.	Pressure	Period	Sap	Preservative	Sap	Preservative
1	2	3	4	5	6	7	8	9	10	11
1	BP	Not known	A	4	20	2·5	1	35	30·0	575·0
2	BP	,,	A	4	20	3·0	1	12	285·0	910·0
3	BP	,,	A	4	20	3·0	1	24	185·0	660·0
4	BP	,,	A	4	20	3·0	2	15	215·0	4000·0
5	BP	,,	A	4	20	3·0	5	10	5·0	770·0
6	BP	,,	A	4	20	3·0	10	35	225·0	25·0
7	BP	,,	A	4	20	3·0	20	25	25·0	105·0
8	BP	,,	A	4	20	3·0	5	6	40·0	..
9	BP	,,	B	10	20	3·0	1	11	140·0	3160·0
10	BP	,,	B	10	20	3·0	5	50	60·0	150·0
11	DS	,,	B	10	20	2·0	..	10	Nil	130·0
12	DS	,,	B	10	20	7·0	7	20	85·0	85·0
13	DS	,,	B	10	20	4·0	12	122	140·0	100·0
14	BP	40	B	10	20	3·0	2	22	45·0	625·0
15	BP	40	B	10	20	3·0	1	31	100·0	385·0
16	BP	28	B	10	20	3·0	3	20	125·0	925·0
17	BP	28	B	10	20	3·0	3	18	70·0	1135·0
18	BP	16	B	10	20	3·0	3	18	165·0	1600·0
19	BP	16	B	10	20	3·0	1	12	125·0	1140·0
20	DS	54	B	10	30	4·5	7	15	100·0	15·0
21	DS	54	B	10	30	7·5	1	167	35·0	15·0
22	DS	54	B	10	20	3·0	2	19	55·0	190·0
23	DS	42	B	10	30	6·0	2	49	130·0	240·0
24	DS	42	B	10	20	3·0	2	12	25·0	170·0
25	DS	30	B	10	30	6·9	25	205	160·0	40·0
26	DS	30	B	10	20	3·0	5	43	55·0	200·0
27	DS	18	B	10	30	6·0	1	172	150·0	50·0
28	DS	18	B	10	20	3·0	3	33	65·0	150·0

and *Bambusa nutans* with Boliden salts (*a*) ; ASCU (*b*) ; Copper-chrome-boric composition (*d*) and fire-proofing-cum-antiseptic composition (*e*)

Size of Bamboos				Volume of preservative absorbed by bamboo in c.c.	Absorption of preservative (dry) in lb.		Absorption of $ZnCl_2$ in lb. (dry) per cu. ft. (by chemical analysis) at 12" from the dripping end
Length in feet	Diameter at thin end and butt end in inches	Wall thickness at thin end and butt end in inches	Approximate volume in cu. ft.		Per bamboo	Per cu. ft.	
12	13	14	15	16	17	18	19
21	..	..	..	..	..	..	..
21	..	..	..	..	..	..	..
21	..	..	..	..	..	..	..
21	..	..	..	..	..	..	..
21	..	..	..	..	..	..	..
21	..	..	..	..	..	..	..
21	..	..	..	..	..	..	..
21	..	..	..	..	..	..	..
21	..	..	..	..	..	..	..
21	..	..	..	..	..	..	..
20	1·05 to 2·25	0·20 to 0·45	0·106	745·0	0·164	1·547	..
25	1·1 to 1·9	0·25 to 0·50	0·134	1595·0	0·346	2·560	..
30	1·0 to 2·2	0·20 to 2·00	0·380	550·0	0·120	0·315	..
21	..	..	..	..	..	..	..
21	..	..	..	..	..	..	..
21	..	..	..	..	..	..	..
21	..	..	..	..	..	..	..
21	..	..	..	..	..	..	..
21	..	..	..	..	..	..	..
27	1·0 to 2·0	0·30 to 1·10	0·237	585·0	0·129	0·544	..
30	1·0 to 1·9	0·40 to 0·60	0·196	490·0	0·108	0·551	..
18	1·0 to 1·6	0·20 to 1·60	0·103	225·0	0·050	0·485	..
26	1·0 to 1·9	0·30 to 1·60	0·284	415·0	0·910	3·204	..
16	1·0 to 1·6	0·40 to 1·60	0·116	230·0	0·051	0·440	..
31	1·1 to 2·1	1·10 to 1·70	0·406	880·0	0·710	1·749	..
20	1·1 to 1·9	0·40 to 1·90	0·192	210·0	0·046	0·242	..
29	1·0 to 2·0	0·40 to 1·50	0·315	950·0	0·210	0·666	..
21	1·0 to 1·55	0·30 to 1·55	0·171	310·0	0·068	0·400	..

(*contd.*)

TABLE No. 3.—Results of treatment of *Bambusa polymorpha* and *Dendrocalamus strictus*
(*c*) Zinc chloride to which 2% of Sodium dichromate was added

Serial No.	Species of bamboos treated	Approximate age of bamboo in months	Preservative used and its % conc. in water		Pneumatic pressure applied on the preservative solution in lbs. and period of treatment in hours		Dripping of sap and preservative at butt end in minutes after start		Valume of sap and preservative flowed out in c.c.	
			Preservative	Conc.	Pressure	Period	Sap	Preservative	Sap	Preservative
1	2	3	4	5	6	7	8	9	10	11
29	BP	53	C	10	20	3·40	1	23	120·0	1535·0
30	BP	53	C	10	20	3·50	1	15	110·0	1115·0
31	BP	41	C	10	20	3·0	3	15	100·0	1325·0
32	BP	41	C	10	20	2·66	1	15	180·0	1930·0
33	BP	29	C	10	20	3·00	1	11	90·0	1540·0
34	BP	29	C	10	20	3·00	2	28	130·0	3065·0
35	BP	17	C	10	20	3·0	1	18	150·0	1250·0
36	BP	17	C	10	20	3·75	1	15	60·0	1175·0
37	BP	52	D	17	25	6·0	1	18	65·0	985·0
38	BP	52	D	17	20	4·0	10	23	55·0	1550·0
39	BP	40	D	17	20	2·0	1	24	115·0	800·0
40	BP	40	D	17	20	3·0	6	20	135·0	1350·0
41	BP	40	D	17	20	3·5	1	9	130·0	2130·0
42	BP	28	D	17	20	3·0	20	50	155·0	1325·0
43	BP	28	D	17	20	3·0	15	20	20·0	950·0
44	BP	16	D	17	20	3·0	1	19	115·0	1485·0
45	BP	16	D	17	20	3·0	21	38	80·0	1325·0
46	DS	54	D	17	30	3·0	11	80	105·0	250·0
47	DS	54	D	17	30	4·66	30	120	75·0	250·0
48	DS	42	D	17	30	5·0	75	160	20·0	425·0
49	DS	42	D	17	30	3·2	1	60	115·0	410·0
50	DS	30	D	17	30	3·75	1	15	60·0	1175·0
51	DS	30	D	17	30	5·5	10	80	100·0	195·0
52	DS	18	D	17	30	3·0	29	80	85·9	105·0
53	DS	18	D	17	30	3·50	10	55	60·0	400·0
54	BN	..	E	25	20	6·0	7	15	15·0	2125·0
55	BN	..	E	25	20	6·0	5	15	50·0	2085·0
56	BN	..	E	25	20	6·0	13	24	15·0	1755·0

and *Bambusa nutans* with Boliden salts (*a*); ASCU (*b*); Copper-chrome-boric composition (*d*) and fire-proofing-cum-antiseptic composition (*e*)—(*concld.*)

Size of Bamboos				Volume of preservative absorbed by bamboo in c.c.	Absorption of preservative (dry) in lb.		Absorption of $ZnCl_2$ in lb. (dry) per cu. ft. (by chemical analysis) at 12″ from the dripping end
Length in feet	Diameter at thin end and butt end in inches	Wall thickness at thin end and butt end in inches	Approximate volume in cu. ft.		Per bamboo	Per cu. ft.	
12	13	14	15	16	17	18	19
21	2·2 to 3·2	0·40 to 1·30	0·417	675·0	0·253	0·607	..
21	2·3 to 3·4	0·30 to 0·50	0·243	340·0	0·075	0·308	..
21	2·3 to 4·6	0·30 to 1·60	0·648	675·0	0·253	0·390	..
21	2·3 to 3·5	0·20 to 0·60	0·248	360·0	0·079	0·319	..
21	2·3 to 2·8	0·15 to 0·80	0·254	310·0	0·068	0·268	..
21	2·4 to 3·1	0·30 to 0·70	0·143	850·0	0·187	1·307	..
21	2·4 to 3·3	0·20 to 0·80	0·356	335·0	0·074	2·073	..
21	2·3 to 2·4	0·20 to 0·40	0·151	775·0	0·177	1·172	..
21	2·4 to 3·0	0·40 to 1·20	0·422	815·0	0·351	0·832	0·46
21	2·3 to 3·0	0·20 to 1·20	0·186	1550·0	0·584	3·140	0·255
21	2·3 to 2·8	0·30 to 1·00	0·331	..	..	..	0·455
20	2·4 to 3·0	0·30 to 0·80	0·288	1225·0	0·495	1·700	0·475
21	2·2 to 3·4	0·20 to 0·30	0·153	75·0	0·637	4·163	0·37
21	2·3 to 3·4	0·40 to 2·80	0·752	675·0	0·223	0·283	0·63
21	2·2 to 3·0	0·20 to 0·20	0·116	435·0	0·163	1·542	..
21	2·3 to 2·7	0·25 to 1·60	0·475	815·0	0·306	0·640	0·435
21	2·4 to 3·2	0·50 to 1·00	0·413	175·0	0·068	0·165	0·46
27	1·0 to 2·1	0·30 to 1·10	0·248	445·0	0·167	0·673	0·37
26	1·0 to 1·8	0·40 to 1·00	0·208	410·0	0·154	0·740	..
26	1·0 to 2·0	0·30 to 0·20	0·940	405·0	0·151	0·160	0·56
26	1·0 to 1·7	0·30 to 1·30	0·216	210·0	0·079	0·364	0·58
28	1·0 to 2·1	0·40 to 1·10	0·270	775·0	0·177	1·118	0·45
25	1·0 to 2·0	0·20 to 1·80	0·273	475·0	0·178	0·652	0·40
26	1·2 to 2·0	0·60 to 1·00	0·272	385·0	0·144	0·526	..
25	1·0 to 1·7	0·30 to 0·90	0·172	540·0	0·202	1·465	0·66
23	2·3 to 3·0	0·5 to 1·5	0·53	2075·0	1·14	2·15	..
25	2·3 to 2·6	0·30 to 1·30	0·45	1615·0	0·88	1·9	..
27	1·7 to 2·6	0·70 to 1·5	0·45	2185·0	1·2	2·6	..

TABLE No. 4

Table showing the recommended preservatives, their concentration, absorption in bamboos and expected service life, for the treatment of green bamboos for diverse purposes.

Serial No.	Diverse uses of treated bamboos	Recommended				Expected service life
		Preservative	Concentration %	Absorption lb./cu. ft. dry salt	Duration of treatment in hrs.	
1	2	3	4	5	6	7
1	Use in the open and in contact with the ground :					
	Fence posts, pale fencing, flag staff, scaffolding	A to C	A C, 8, B–4	A, B, C 0·3 to 0·4	3–4	10–15
	Supports to cane and betel plant ..	E	E–10	0·3	2	8–10
2	House building – rafters, purlins, trusses, tent posts, etc.	A to E	A & C–6 ; B–3 ; D–8 ; E–10	A to D–0 ; 0·2 to 0·3 ; E 0·5	2–3	15–20
3	Reinforcing concrete walls	E & F	6	0·2	1–2	25–30
	Chicks, ceiling and door panels ..	F, G, H, I	F, G, H–6 ; I–2	0·1–0·2	1	10
	Reinforcing mud walls	D & E	D–6 ; E–8	0·2 to 0·3	2	10–15
4	All utility articles like baskets, winnows, sieves, etc.	G & H	5	0·1	0·5	5–8
5	Prophylactic purposes	A to I depending on end use of bamboo	6–8	0·05	0·5	5
6	Fire protection { inside house ..	J	25	2 to 3	6 to 8	15–20
	Fire protection { open ..	,,	,,	,,	,,	10–15

A Ascu : composition .. .. As_2O_5 : $CuSO_4$, $5H_2O$: $Na_2Cr_2O_7$ :: 1 : 3 : 4.

C Celcure : composition .. .. $CuSO_4$: $Na_2Cr_2O_7$: Acetic acid :: 5·6 : 5·6 : 0·25.

B Boliden salts S25

D Copper-chrome-boric composition .. Boric acid : $CuSO_4$, $5H_2O$: $Na_2Cr_2O_7$ :: 1·5 : 3 : 4.

E Chromated zinc chloride .. .. Zinc chloride : $Na_2Cr_2O_7$ :: 1 : 1.

F Zinc chloride plus Sodium dichromate .. $ZnCl_2$: $Na_2Cr_2O_7$ :: 5 : 1·5.

G Boric acid + borax + sodium dichromate.. Boric acid : Borax : $Na_2Cr_2O_7$ :: 2 : 2 : 0·5.

H Boric acid + borax .. .. Boric acid : Borax :: 1 : 1.

I Sodium pentachlorophenate

J Fire-proof-cum-antiseptic composition .. Boric acid : $CuSO_4$, $5H_2O$: $ZnCl_2$: $Na_2Cr_2O_7$: 3 : 1 : 5 : 6.

TABLE NO. 5

Table giving addresses of firms dealing with preservative chemicals and approximate cost per cwt.

Serial No.	Preservative	Address of firms	Cost per cwt.
			Rs.
1	*Ascu[1] and *Copper-chrome-boric-composition[2] ..	A	84[1]; 83[2]
2	*Boliden salts (S-25)	B	158
3	Copper sulphate	C & D	88
4	Arsenic pentoxide	G	65
5	Zinc chloride	C & G	62
6	Sodium dichromate..	H	85
7	Boric acid and borax	G	37
8	Sodium pentachlorophenate	E & F	242

* Patented compositions.

(1) For Govt. use only.

(2) Without royalty.

A M/s. Ascu Wood Products Ltd., 6, Mangoe Lane, Calcutta.

B M/s. Larsen & Toubro Ltd., Engineers, P.O. Box No. 98, Bangalore—1.

C M/s. Bengal Chemical & Pharmaceutical Works Ltd., Calcutta.

D M/s. Imperial Chemical Industries (India) Ltd., Kanpur.

E M/s. Shalimar Tar Products (1935) Ltd., 6, Lyons Range, Calcutta.

F M/s. Monsanto Chemicals of India Ltd., P.O. Box No. 344 A, Bombay—1.

G M/s. Suresh & Co. Ltd., 57, Lohar Streat, Bombay—2.

H M/s. The Pioneer Chromate Works Ltd., P.O. Box No. 1084, Bombay—1.

TABLE NO. 6

Statement showing Annual Yield of Bamboos in the various States of India

Serial No.	State	Total land area (Sq. miles)	Population according to 1951 census (in thousands)	Total Forest area (Sq. miles)	Annual yield of bamboos in thousand tons
1	2	3	4	5	6
1	Assam ..	85,007	9,690	21,923	251
2	Bihar ..	70,330	40,219	13,900	..
3	Bombay ..	1,11,434	35,944	17,504	293
4	Madhya Pradesh ..	1,30,272	21,328	40,907	..
5	Madras ..	1,27,790	56,952	33,696	..
6	Orissa ..	60,136	14,644	4,552	..
7	Punjab ..	37,378	12,639	4,873	..
8	Uttar Pradesh ..	1,13,409	63,254	21,874	48
9	West Bengal ..	30,775	24,787	3,831	13
10	Hyderabad ..	82,168	18,653	9,455	..
11	Jammu & Kashmir ..	92,780	4,370	11,058	..
12	Madhya Bharat ..	46,488	7,942	14,153	57
13	Mysore ..	29,489	9,072	4,561	95
14	P.E.P.S.U. ..	10,078	3,469	331	..
15	Rajasthan ..	1,30,207	15,298	12,782	..
16	Saurashtra ..	21,451	4,136	631	2
17	Travancore-Cochin ..	9,144	9,265	3,056	..
18	Ajmer ..	2,417	593	593	..
19	Bhopal ..	6,879	838	1,550	..
20	Bilaspur ..	453	128	200	..
21	Coorg ..	1,586	229	1,156	55
22	Delhi ..	578	1,744	..	..
23	Himachal Pradesh ..	10,451	989	3,012	7
24	Kutch ..	16,724	568	169	..
25	Manipur ..	8,628	579	2,250	..
26	Tripura ..	4,032	650	3,610	..
27	Vindhya Pradesh ..	23,603	3,577	7,968	67
28	The Andamans and the Nicobar Islands ..	3,125	31	2,500	..
	TOTAL ..	1,266,892	3,61,688	2,42,104	888

TABLE NO. 7

Statement showing quantities and cost of timber, bamboos and grasses including preservative treatment required for building houses shown in Fig. 1. (Cost of labour is not included)

Type of house	Requirements of timber in c. ft.		Requirements of bamboos Nos.		*Requirements of thatch grass*	Total requirements			Requirements of preservative (Ascu) for the treatment of			
	Walls	Truses	Walls	Roof	lb.	Timber c. ft.	Bamboo c. ft.	Thatch grass lbs.	Timber	Bamboo	Grasses	Total
1	2	3	4	5	6	7	8	9	10	11	12	13
A	70	90	200	100	10,000	160 Rs. 640	300 Rs. 90	10,000 Rs. 315	48 Rs. 48	90 Rs. 90	334 Rs. 334	.. Rs. 1517
B	30	45	100	50	4,000	75 Rs. 300	150 Rs. 45	4,000 Rs. 126	22·5 Rs. 22·5	45 Rs. 45	134 Rs. 134	.. Rs. 672
C	45	45	100	50	4,000	90 Rs. 360	150 Rs. 45	4,000 Rs. 126	27 Rs. 27	45 Rs. 45	134 Rs. 134	.. Rs. 737
D	35	45	*100*	*50*	*3,000*	80 Rs. 320	150 Rs. 45	3,000 Rs. 95	24 Rs. 24	45 Rs. 45	100 Rs. *100*	.. Rs. *629*

The following rates were taken into consideration in the above calculations :—

(1) Timber—*chir* @ Rs. 4/- per c. ft.

(2) Bamboos— @ Rs. 6/- per 20 (each bamboo is equal to 1 c. ft.).

(3) Thatch grass— @ Rs. 50/- per 1,000 pulas or 1,600 lbs.

(4) Ascu— @ Re. 1/- per lb. including transport and cost of treatment for Govt. use.

(5) Absorption of preservative per c. ft. – 0·3 lb. for bamboos, and timber, and 0·3 lb. per 10 lbs. of grass.

(6) Anticipated life 15 to 20 years.

TABLE No. 8

Annual charges[1] *for treated and untreated timber, bamboos and thatch grass for house building purposes*

Materials used	Service life in years		Initial cost Rs.	Cost of[2] treatment Rs.	Total cost of treated material	Annual charges Rs.	
	Untreated	Treated				Untreated	Treated
1	2	3	4	5	6	7	8
Timber *Chir* (*Pinus longifolia*).	2	15 to 20	4 per c. ft.	1/3	4⅓	2·16	0·433 to 0·350
Bamboos	2	15 to 20	6 for 20 (1 c. ft. each)	6	12	3·44	1·20 to 0·96
Thatch grass (local, Dehra Dun).	2	15 to 20	50 for 1000 pulas or 1600 lbs.	48	98	27·00	9·80 to 7·84

(1) Annual charges or the cost per year required to extinguish an interest bearing debt during a period of years corresponding to the life of the material in service. The interest is taken at 5 per cent which includes interest at 3 per cent and expenses for annual maintenance at 2 per cent on capital. The formula used for this calculation is $A = P\left(r + \frac{r}{(1+r)^n - 1} \right)$ where A is the annual charge or cost per year; P is the first cost of the material; r is the rate of interest (expressed in decimal) and n is the estimated number of years of service.

(2) The cost of treatment is calculated at 0·3 lb. absorption of the preservative Ascu for 1 c. ft. of timber or bamboo and 0·3 lb. for 10 lbs. of thatch grass. The cost of the preservative including transport charges and treatment costs is taken at Re. 1/- per lb. for Government use.

THE CORRECT NAME OF PIPLI
(*BUCKLANDIA POPULNEA* R. BR. EX GRIFF.)

BY M. B. RAIZADA
Forest Research Institute, Dehra Dun

Pipli is a large evergreen handsome tree with bright shining poplar – like leaves and fleshy stipules. It is confined to the Eastern Himalayas, Naga and Khasi Hills and hills of Martaban extending eastwards to South China, Malaya Peninsula, Sumatra and Java.

The tree is very easily spotted in the forest. The bark of poles is rough and black, that of old trees reddish-brown and deeply furrowed. The crown is dense and spreading and the leaves are cordate, shining and coriaceous. Moreover the stipules are thick and fleshy, oblong-obtuse in shape, paired over the apical bud. It is one of the best trees for afforestation in the Darjeeling hills and has been extensively used for the protection of hill-slopes liable to erosion. The wood is reddish-brown, smooth, moderately hard, close-grained, durable and is very much used in Darjeeling for planking, beams, door and window frames, and is in considerable demand. It is also used for tea chests and has been found suitable for the manufacture of plywood.

Recently C. G. G. J. Van Steenis (*Acta Botanica Neerl.* Vol. 1, October 1952, 443–44 – a copy of which has just been received in the Library of the Botany Branch) has contended and proved that under the International Code of Botanical Nomenclature the generic name *Bucklandia* cannot be retained, being pre-occupied at the time it was published. He has, therefore, proposed the name *Symingtonia*. The correct name for the Pipli tree (*Bucklandia populnea* R. Br. ex Griff.), therefore, becomes *Symingtonia populnea* (R. Br. ex Griff.) Van Steenis.

The arguments and views of Van Steenis are somewhat as follows (loc. cit.) and are reproduced below at times verbatim :

The generic name *Bucklandia* R. Br. has mostly been cited ex WALL. Cat. (1830) no. 7414. However, this is a nomen nudum which was validated ex GRIFF. (in As. Res. 19, 1, 1836, p. 94, t. 13–14).

The same name had, however, been given in honour of the same person (William Buckland, an eminent British geologist) already in 1825 by PRESL in STERNBERG'S folio book "Versuch einer geognostisch-botanischen Darstellung der Flora der Vorwelt" which (acc. to the title page) consists of four parts, with a principally German text. The Leyden copy contains next to that, a Latin-paged part covering xlii pages + index in which many new genera and species of fossil plants have been described manifestly edited separately and bearing the title "Tentamen florae Primordialis". This part is mentioned by PRITZEL (p. 306a) to belong to this work. In palaeobotanical literature it is apparently ascribed to PRESL., and the appertaining novelties are provided with the author's name "Presl in Sternb". The introduction of this Latin descriptive part is dated "Pragae 27. Aprilis 1825", and it is generally accepted to have appeared in 1825. This is corroborated by a note in Flora (Bot. Zeit.) 1825, Bd. II, Beil., 3, p. 33–35.

In this work a fossil genus *Bucklandia* Presl. in Sternb. is described belonging to the Tertiary Cycadaceae, typified by *Clat(h)raria anomala* Mantell as *Bucklandia anomala* (Mantell) Pr. in Sternb. This genus is recognized in reference works up to the present day and several other species have been referred to it.

In 1828 BRONGNIART had apparently a different opinion about the identity of *Bucklandia anomala*, and reduced it again (Prod. Hist. Veg. Foss.) to *Clathraria* (as *Cl. lyelii* Mantell), at the same time erecting another genus *Bucklandia* (apparently a superfluous name) based on *Conites bucklandi* Sternb. This procedure is of course illegitimate as *Bucklandia* Brongn. is a clear homonym of *Bucklandia* Pr. in Sternb. It is likely that they are synonyms, but this is irrelevant. For the present the main point is that according to the Rules of Botanic Nomenclature it appears that the generic name *Bucklandia* was pre-occupied at the time it was published for the living genus of the Hamamelidaceae. As the latter has no synonyms there seems no other way out than giving it a new mane. For this the name *Symingtonia* is proposed in honour of Mr. C. F. SYMINGTON, late Forest Botanist in the Forest Research Station, Kuala Lumpur, whose lamented death deprived Malaysian botany of one of its prominent students.

The allied genera are, according to CHANG (Sunyatsenia 7, 1948, p. 63 seq.) *Mytilaria* and *Chunia ;* the latter seems closest allied to *Symingtonia.*

SYMINGTONIA, Van Steenis nom. nov.

Bucklandia R. Br. ex GRIFF. in As. Res. 19, 1 (1836), p. 94, t. 13–14; non PRESL, in STERNB. Tent. Florae Primordialis (1825), p. xxxiii; nec BRONGN. Prod. Hist. Veg. Foss. (1828), p. 128.

Symingtonia populnea (R. Br. ex GRIFF.) Van Steenis – *Bucklandia populnea* R. Br. ex Griff. l.c., Hk. f. Fl. Br. Ind. 2 (1878) 429 – *B. populifolia* Hk. f. and Th. Journ. Linn. Soc. 2 (1858) 86. – *Liquidambar tricuspis* Miq. Fl. Ind. Bat. 1 (1858) 1097.

The Malaysian specimens differ a little from those of continental Asia in having generally somewhat smaller leaves and narrower, more hairy stipules. There is, however, no sharp distinction.

Both in Malaysia and continental SE. Asia *Symingtonia* is growing under the cool hill conditions of the montane zone, 1,000–2,400 m. altitude, from India and Tonkin down to the Malay Peninsula and throughout Sumatra.

VANA MAHOTSAVA AT THE NATIONAL CHEMICAL LABORATORIES, POONA

(*Speech of Shri K. F. Patil, Deputy Minister for Agriculture and Forests, Government of Bombay, Bombay, on the 6th August, 1953*).

"Director, Staff of National Chemical Laboratories and Friends :

"I am glad to be in your midst to-day to take part along with you in the celebrations of the *Vana Mahotsava* of your pioneer institution. I had some occasions last year to come in contact with you and am glad to know that the Forest Department has associated itself with your institution in tree plantation.

"Though Bombay State was the first in organizing tree planting festival in 1950, the credit of giving the tree planting a National Character as *Vana Mahotsava* goes to the Central Government. The national festival of India has now become an international one since most countries outside India have adopted the tree planting as world festival.

"*Vana Mahotsava* is primarily meant to draw the attention of the public and create in the mind of the people the feeling of 'tree-sense'. It is to educate the ordinary man in the street about the importance of tree planting and rearing it up, in our national life. Most of us do not know the very significance part the tree plays in our national economy. *Vana Mahotsava* impresses the need not only to protect, and preserve the trees that have been handed down to us but to plant, protect and conserve sufficient number of trees for future generation. Forest requires a long range policy for maintaining a sustained yield for generations to come. We will have to plan ahead for centuries to ensure regular supply.

"Government is doing its best to rehabilitate the barren lands with vegetational growth. Afforestation and regeneration of tree growth are being done by the Forest Department according to schedule. It is developing and organizing the forest on a scientific method though the progress is very slow due to financial and other difficulties. It has its own working plans which are prepared taking into consideration all the relevant aspects of our national life. Due to the vastness of the area involved and largeness of the task before us it is felt that efforts of Government alone are not enough. It is such a problem that it requires that public should take interest and help the nation by helping themselves.

It is said by the experts that at least 30% of the total land should be under forest area. The percentage on all-India basis works out to be about 19% and Bombay State in particular has almost the same percentage. Even this percentage is very unevenly divided. If Kanara has got 80% of the land under forest, Sholapur, Ratnagiri, Ahmednagar and parts of Banaskantha and Sabarkantha and Bijapur have nothing worth calling forest.

"To keep the balance of climatic conditions, perennial water supply – both for irrigation and other purposes, to create the fertility and stability of the soil and to keep it intact and to supply innumerable requirements of the people it is essential to have at least 1/3 of the land in the country under forest. The State Government will have, therefore, to base their policy in granting land for cultivation keeping this view of national requirement before their mind. It is worthwhile quoting in this connection Shri Punjabrao Deshmukh, Minister for Agriculture and Forests in Union Government. He says : 'There has been such an unceasing demand for agricultural land, that often times flourishing forests were cut down to turn them into agricultural lands. I particularly refer to the irrational demand for cultivation on the hill slopes subject to landslips and erosion. I have, often reiterated that it would be false

rural economy to let agricultural land encroach upon valuable forests, and that the solution of the food problem of an ever-increasing population must be sought primarily in intensive cultivation and not in weakening the very basis of national existence by encroaching upon such forests. I had thus pleaded that we should decide on a balanced rural economy and land usage giving importance to both agriculture and forestry in their sphere and dispel the existing antagonism'. That is why Government is releasing forest land for cultivation wherever possible mainly on *sanad* basis for fruit tree cultivation and agri-silvi basis, etc. The public should realize that it is the national need to maintain forests and help the State in carrying out its rehabilitation programme. The much needed timber, fuel, fodder and supply of innumerable forest products can be augmented by increasing forest area, organizing and developing village wood-lands and grass-lands on a systematic basis. Special emphasis is being given in this year's *Vana Mahotsava* particularly in raising quick growing trees which are useful to the villages to solve the fuel problem and to divert the much needed cow-dung for manure. No less important is the growing of other trees also which are useful for our daily life.

"Government is also encouraging the planting trees by the public on roadside, railway tracts, *gaothana* sites, canal banks, embankments, tank bunds and everywhere; where it is not possible to cultivate. Some rights over such trees planted by the people are given to them. Prizes are also being awarded to one village in each district which plants and rears the highest number of trees. It should be the responsibility of the people to see that trees once planted are not neglected. Attention and tender care will have to be given to the plants in the first two or three years. Sustained effort is required to achieve success in growing trees. My observation is that more trees planted by individuals have survived than those planted in common by the public. The reason is not far to seek. We have still to develop higher sense of security and safety for whatever is common and public property than for private property. No doubt it is a very long way from private property to public property. But concentrated efforts will have to be started at some point. Earlier we realize the importance the better for us. It is in the interest of the national welfare that we do so. It is high time now that we have to cultivate our thoughts and habits on the lines of community welfare rather than on the individual welfare. Because individual safety, security, welfare and healthy development is possible only if the safety, security, welfare and development of the country as a whole is attained. I for one judge the success or otherwise of the *Vana Mahotsava* on the number of trees survived and not on the number of trees planted in common by the public.

"Recently we have been hearing of disastrous floods and small villages and big towns alike are being victimized. It is a sad story of innumerable sufferers. Ratnagiri, Kolhapur and Belgaum seem to be more affected by the recent floods in our State. If we could look into the cause a little minutely and deeply, we realize that ruthless cutting of trees somewhere in the catchment areas of the *nalas* and river beds and hill slopes, etc., has been the main cause for this great calamity. Unless we take care to control the soil erosion effectively now, other areas may also follow suit. I feel we should take a lesson now from these incidents and organize in such a way that no such catastrophies occur in future.

"There is no doubt that cutting of trees in the catchment areas of *nalas* and rivers lead to these sorts of floods. People are since time immemorial in the habit of destroying the great green glory and are leaving bald hills and barren lands which cause floods. It is all due to the faulty utilization of land and to the mismanagement by human beings that our civilization has suffered a lot in the past. The soils upon which men had attempted to build new civilizations have disappeared in the past on account of ruthless destruction of our forests. It is now no wonder if history repeats itself in other areas, due to destruction of forests indiscriminately.

"Trees act as barriers to the destructive effects of winds and flow of water and help in raising shelter belts and wind-breaks in villages to give protection to fields. The tree is said to be the 'Lord Protector' of our very existence in as much as its roots and humus of its leaves not only build up the soil but also shield it against wind, water, erosion, and heavy run-off, washing off the top fertile layer of soil. It is the vegetation and animal organic matter of the the soil content that helps to bind the soil particles together and to make it strong enough to withstand the force of run-off of water. It is mainly due to this factor that stability and fertility of soil is maintained. Many of us do not realize that every blade of grass acts as a bund in arresting the velocity and force of every drop of rain water and thus helps to control floods. The only thin living cover on the earth is slowly proceeding at a rate unparalleled in history and when that thin cover is gone, the fertile land will be like Sahara.

"There are two ways of controlling the soil erosion. One is mechanical and the other biological. Our engineering science has developed recently to a very great extent. Our engineers would try to stop floods by putting up dams across *nalas* and rivers and creating wells along river banks, etc. But I am afraid this alone will not be enough to solve the problem permanently and effectively though it has its usefulness. Unless we have sufficient tree-growth in the catchment areas of *nalas*, the floods would not be controlled effectively and permanently. I think in the first instance it is more a forester's job rather than that of the engineer to create condition which will not give birth to the floods so that the question of control does not at all arise. It has been abundantly proved that patchwork erosion control is only a temporary palliative ; control, to be permanently effective, must embrace entire natural regions and must seek at removing the cause rather than the consequences of erosion. It is admitted that an outstanding feature of the modern outlook on soil conservation is the emphasis laid on the superior value of biological, as compared with mechanical, erosion control. If the soil is performing its natural biological functions of feeding and being fed by living organisms, it will not in general erode seriously. Biological soil conservation is not new ; indeed the cultural operations that were evolved to keep humid soils 'in good heart' may be regarded as biological measures of soil conservation. They improved the soil structure, aeration and drainage and by enabling the soil to support a rich flora and fauna kept the plant nutrients circulating in the surface layers.

"Soil is the fundamental environment on which humanity lives and prospers. Civilizations have sprung up from the forests and civilizations will have their dooms day when all the forests are annihilated. I think we are forgetting that conservation, stability and fertility of the soil is closely connected with the presence of forests and civilizations. I remember the French adage that 'Forests precede man and deserts follow him' which is most subtle and appropriate. We can see why even our forefathers and great seers looked at trees with admiration and reverence. The great writers of East and West alike have talked of great forests in their great poems. Tagore found 'sacred solitude in forests' and Shakespeare found 'tongues in trees'.

"Cultivation, deforestation or the destruction of the natural vegetation by grazing or other means, unless carried out according to certain immutable conditions imposed by each region, may accelerate denudation. The equilibrium between denudation and soil formation is easily disturbed by man. This man-accelerated denudation or soil erosion, as it is called, can be checked in its early stage only. If it is once allowed to spread, then it becomes uncontrollable. It is a very great national calamity and it should be the duty of every one to help in controlling it before it assumes the magnitude of a national evil.

"The erosion is already taking its toll of soil fertility with increasing speed. Scientists are finding out some one or the other remedy either to augment the food crops or to reclaim the

land but science has its limitations and a nation cannot survive in a desert. Erosion has humbled mighty nations, reshaped their domestic and external policies and it has barred the way to the *El Dorado.* Erosion is essentially a problem relating to the maladjustment of humun communities to their environment, i.e., it is a fundamental problem in humun ecology. Faulty utilization of land is the main cause of soil erosion. We have to cut at the root of the cause by going back to nature.

"For human prosperity it is necessary to gain control over the soil and I feel that mankind is quite capable of it. It is a challenge to scientists and experts. Ordinary men like me look to them for help. It is up to the scientists to find out ways of making our country flow with milk and honey. They seem to have come to the conclusion that human civilization can be saved by arresting the daily developing desert and converting it into the fertile, stable and productive soil. The sovereign remedy that is easily available at present is growing trees on every inch of land that is available and I am particularly happy on this account to-day to be in the midst of scientists for the tree plantation work. We should all work in the direction with the zeal of missionaries and wait for the results with patience and confidence.

"I thank you for the honour that you have done to me by creating an opportunity for me to associate myself with you all on this happy occasion.

"I thank you all once again".

Shri K. F. Patil, Deputy Minister for Forests and Agriculture, Bombay State, after planting a seedling of *Pithecolobium saman* at National Chemical Laboratory, Poona 7.

Shri K. F. Patil, Deputy Minister for Forests and Agriculture, Bombay State, watering the seedling planted by him at National Chemical Laboratory, Poona 7.

WILD-LIFE PRESERVATION IN BOMBAY STATE

BY J. V. KARAMCHANDANI, B.SC., F. (EDIN.)
Conservator of Forests, Central Circle and Wild-Life Preservation Officer, Bombay State

PART III

The general opinion which is popularly prevailing amongst indigenous *Shikaris* is that the villager possessing a gun for crop protection is mainly responsible for destruction of wild-game. I hold no brief for such villager but it will be interesting to know in fairness to him the extent to which he is actually responsible for such destruction. His *modus operandi* is usually watch by night whether lawfully in his field or unlawfully and surreptitiously over water or game path with a smooth-bore gun. This method of hunting apart from being wearisome is not always fruitful, considering the limited scope both in regard to the field of operation and range of the weapon – coupled with poor visibility and uncertainty of aim. It is when a number of villagers combine as they sometimes do, with nets or dogs or both, they may do a little better, but even then such organized *hakas* are not on the whole more productive than a solitary watch. Furthermore, such organized *hakas* being illegal have to be conducted in a 'hush hush' manner, which is not always possible, considering the number and noise involved ! They are not, in consequence, frequently organized nor such huntings cause the destruction which one is lead to believe. It is also a matter of opinion if there is any money for the villager in the venture considering the risk involved, beyond perhaps 'meat for the pot'.

In context with the above, there is another kind of an agent for destruction of wild-game. One very different and much more efficient than the local resident, i.e., villager, the Motoring Poacher ! Armed with efficient arms and provided with latest equipment in spot-light, etc., he does not only operate over much wider sphere with mobility but hunts with accuracy of his arm. Obstruction much less apprehension of this kind is not only arduous in its results but equally hazardous. As he often hunts for money, he has his contacts and resources and the aggregate destruction of wildgame is more particularly concentrated in and around areas which are easily accessible from large cities.

Between the two – the villager and the motoring poacher, the later is obviously more of a menace to the wildgame. It is this type of a poacher who is Enemy No. 1 and is to be hunted down and brought to book if we are to salvage over valuable and fast vanishing heritage from complete annihilation. Under provisions of the Bombay Wild Animals and Wild Birds Protection Act, 1951, no game licence is necessary to hunt *Vermin*. The motoring poacher is the biggest *Vermin* of all *Vermins*, since he has no respect even for sex and kills indiscriminately. He is, in my opinion, the one who needs to be liquidated, if we are to conserve what is left of Wild-life.